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DISPLACEMENT OF CHOROIDAL PLEXUSES AS AN AID IN THE DIAGNOSIS AND LOCALIZATION OF BRAIN TUMOR

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RECENTLY Lowman and von Storch (4) have called attention to the displacement of the calcified choroidal plexus of one of the lateral ventricles in a case believed to be due to hemorrhage into the left temporal fossa, secondary to rupture of a left carotid aneurysm. Undoubtedly, roentgenologists for years have thought of this type of displacement as a possible means for localizing brain tumor, but it is a salient fact that in searching for the displacement, it has seldom been found. The recent literature shows practically no papers devoted to this subject (except for the single reference above), though papers are quite numerous dealing with intracranial calcification (1, 2, 3, 5, 6, and 7). In recent years, during which this displacement has been diligently sought for, we have had our efforts rewarded by detection of five cases of space-occupying masses of this kind.[1] In all of these, with one exception (this patient refused all operative procedures and was discharged against advice), the presence of a large intracerebral mass was verified by ventriculography, operation, or autopsy.

Case 1. 132,606. H. E. L. Left posterior cerebral tumor in a male subject 44 years of age. Indefinite localizing signs. Displacement of pineal gland to the right of the midline. Displacement of left choroid plexus upward and medially. Verification of massive tumor by ventriculography. Refusal of further operative procedures with death supervening at home 13 months later.

A male, 44 years of age, entered Strong Memorial Hospital Sept. 27, 1937, complaining of vomiting, frontal headache, and convulsions. Examination revealed aphasia, chiefly motor in type, absence of cranial palsies, and an accentuated right Achilles reflex. The spinal fluid was found under increased pressure on lumbar puncture (275 mm. H_2O) showing increased globulin content and increased cellular content (112 lymphocytes).

Skull films showed a calcified pineal with a definite shift to the right of the midline

[1] To Dr. W. P. Van Wagenen my thanks are particularly due, all of the cases reported coming from his Neurosurgical Clinic. The writer is also indebted to Dr. W. B. Hawkins, of the Department of Pathology, for the use of the autopsy report of one of the cases. In several of the cases, displacement of the choroid plexus was first suspected by Dr. John J. Jares of Lakeland, Florida, who was requested to watch for this type of displacement during his routine work as resident at our clinic and whose diligence was rewarded twice within a year. His assistance in collecting this group of cases is most gratefully acknowledged.

and a calcified choroid plexus of the left lateral ventricle which was displaced upward approximately one centimeter and somewhat crowded toward the midline. The plexus of the right lateral ventricle was calcified and showed a slight amount of lateral displacement. Other features of the skull were without interest, except for the finding of a moderate diastasis of the lambdoidal suture. Our impression was summarized as follows: "The position of the pineal gland and of the left choroidal plexus gives localizing information of value . . . suggesting a space-occupying mass in the posterior portion of the left cerebrum." (Fig. 1.)

A ventriculogram confirmed the shifting of the lateral ventricles to the right, the third ventricle being tilted toward this side in its upper portion. Unfortunately, no films were obtained with the brow down against the table to permit filling of the posterior horns and our films permitted us only to rule out deformities in the anterior and temporal portions of the lateral ventricles.

The patient was followed for several months after his discharge from the hospital, with the diagnosis of "brain tumor—not localized." During these months he complained of double vision and on examination was found to have an abortive nystagmus, on looking to the right. His diplopia was attributed to weakness of the left superior and left external rectus muscles. He was advised to re-enter the hospital for a repetition of the ventriculography, but this appointment was not kept, the patient succumbing 10 months later at home on Oct. 24, 1938.

Case 2. 133,239. J. Q. Left temporoccipital glioblastoma multiforme in a male subject 73 years of age. History of progressive paresis of right arm and leg, coma and mental changes. Displacement of pineal gland to the right of the midline. Displacement of left choroid plexus upward and medially and of right choroid plexus laterally. Operation not advised due to patient's condition. Death one month following admission, with verification of tumor by autopsy.

A 73-year-old male entered the Strong Memorial Hospital on Oct. 20, 1937, in a semicomatose condition. Five days before

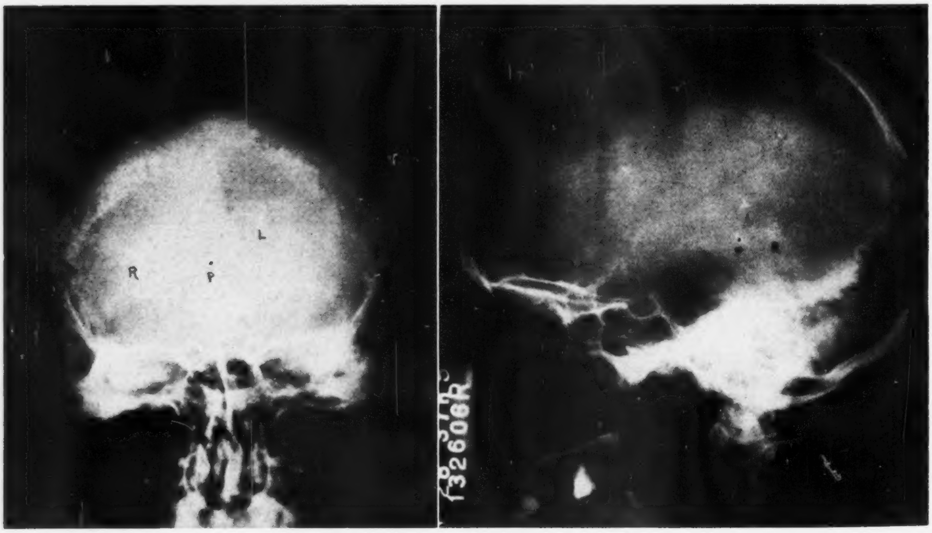

Fig. 1. Case 1. 132,606. H. E. L. Left posterior cerebral tumor in a male subject 44 years of age. Indefinite localizing signs. Displacement of pineal gland to the right of the midline. Displacement of left choroid plexus upward and medially. Verification of massive tumor by ventriculography. Refusal of further operative procedures with death supervening at home 13 months later.

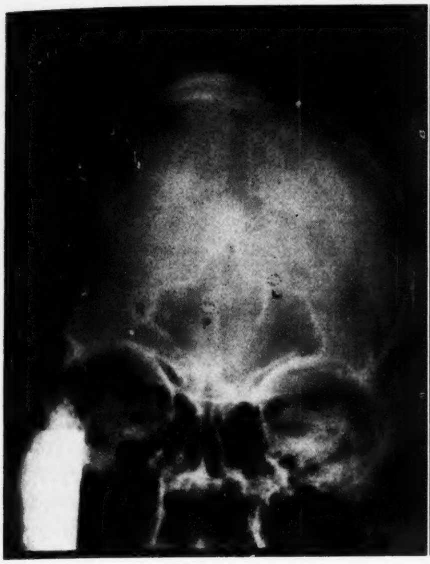

Fig. 2-*A*.

Fig. 2-*B*.

Figs. 2-*A* and 2-*B*. Case 2. 133,239. J. Q. Left temporoccipital glioblastoma multiforme in a male subject 73 years of age. History of progressive paresis of right arm and leg, coma and mental changes. Displacement of pineal gland to the right of the midline. Displacement of left choroid plexus upward and medially and of right choroid plexus laterally. Operation not advised due to patient's condition. Death one month following admission, with verification of tumor by autopsy.

entry aphasic disturbances were noted by members of his family, followed by gradual progressive paralysis of right arm and leg and mental changes. His past history was not remarkable, except for prostatectomy six years ago.

His physical examination showed a flaccid paralysis of the right arm and leg without any paralysis of the facial muscles. He was unable to speak but could partially carry out commands. His reflexes were all present but diminished on the right side with a definite positive Babinski reaction on that side.

Skull examination showed a normal calvarium and a moderate atrophy of the sella. There were several forms of calcification, one of which definitely related to the pineal gland which was obviously displaced to the right of the midline, but which was noted to be in normal position on the lateral film. The right choroid plexus was readily visualized, due to its calcium content, and appeared slightly displaced to the right of its normal position. The left choroid plexus was not identified with certainty at the time of the examination, but a review of these films at the time of writing would indicate that the failure to iden-

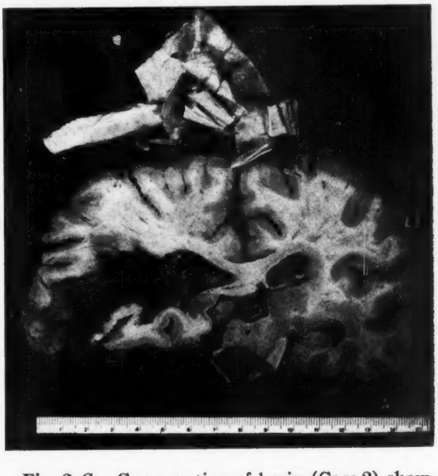

Fig. 2-*C*. Cross-section of brain (Case 2) showing tumor.

tify this calcification as the plexus was due to its marked displacement, the gland appearing grossly displaced upward and slightly medially. Calcification was also noted at the base of the brain (circle of Willis), indicating arteriosclerosis of one of the vessels of this network (Fig. 2).

A lumbar puncture showed the spinal fluid under normal pressure with an elevated white count of 84 cells per cubic millimeter (all polymorphonuclears) and an elevation of protein content (total protein content, 200 mg. per cent). The Wassermann reaction of the spinal fluid was normal.

A neurologic consultant considered a vascular accident as the probable cause of the right hemiplegia and mixed aphasia following the lumbar puncture, but subsequently believed a pachymeningitis remained a likely possibility. A neurosurgeon favored an opinion of cerebral thrombosis unless the x-ray films revealed a pineal shift.

With the discovery of a pineal shift, a burr hole was made in the left posterior parietal region (Dr. W. P. Van Wagenen). There was no evidence of local clot. Attempts to fill the left lateral ventricle were unsuccessful, probably due to its collapsed condition. In view of his age and general condition, further operative procedure was thought to be inadvisable. He remained comatose following the operation except for a brief interval during which time he was unable to speak. His condition gradually became worse, death ensuing on Nov. 17, 1937. Diagnostic impression: left cerebral tumor, general arteriosclerosis; thyroglossal duct cyst; hypertrophic arthritis.

At autopsy, the brain showed congestion of vessels at the surface and flattening of the convolutions. At the left temporal region the brain was slightly adherent to the dura, and the convolutions were obviously deformed. Cross-sections of the brain, following fixation, showed the tumor to extend within four centimeters of its tip and posteriorly to within three centimeters of the tip of the occipital lobe. The appearance of the tumor was modified by hemorrhage producing a reddish-brown discoloration. It was encapsulated and did

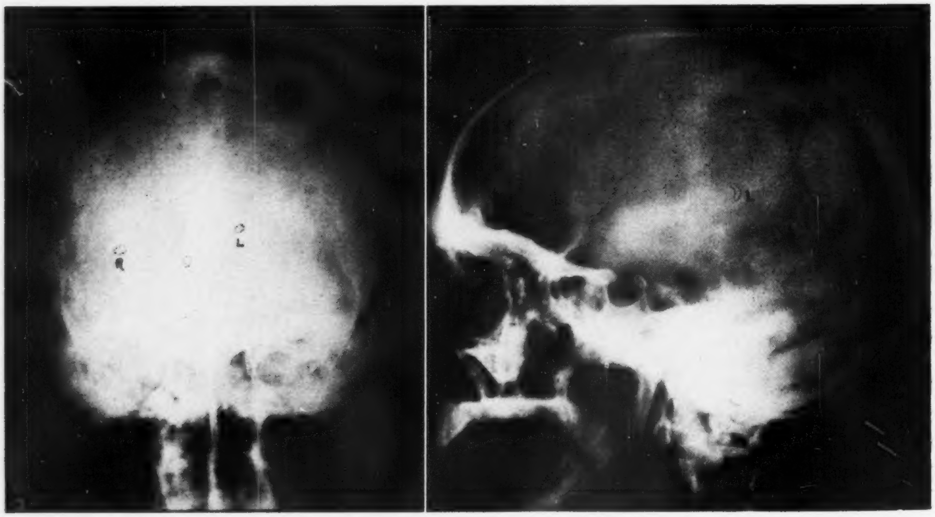

Fig. 3. Case 3. 105,898. C. K. Left posterior cerebral tumor verified (glioblastoma multiforme) in a male subject aged 61 years. Displacement of left ventricular choroid plexus forward, medially, and upward. Displacement of pineal gland to the right of the midline. Verification of a massive tumor by left temporo-parietal craniotomy, localizing the tumor in temporal, parietal, and occipital lobes. Subsequent treatment by roentgen therapy.

not involve the internal capsule, but extended medially to come in contact with the lateral wall of the left lateral ventricle. Examination microscopically showed much necrotic material with evidence of hemorrhage. The predominant cell at the periphery of the mass was a fusiform cell with scanty cytoplasm and an oval vesicular nucleus. Many of these cells showed mitotic figures. Diagnostic impression: glioblastoma multiforme, temporoccipital in location.

Case 3. 105,898. C. K. Left posterior cerebral tumor verified (glioblastoma multiforme) in a male subject 61 years of age. Displacement of left ventricular choroid plexus forward, medially, and upward. Displacement of pineal gland to the right of the midline. Verification of a massive tumor by left temporoparietal craniotomy, localizing the tumor in temporal, parietal and occipital lobes. Subsequent treatment by roentgen therapy.

A 61-year-old male sheet-metal worker entered the Rochester Municipal Hospital with complaint of headache, dizziness, visual disturbances, and difficulty with speech.

Six months prior to entrance he had experienced a transitory attack of vertigo without loss of consciousness followed by a period of listlessness and forgetfulness. One week prior to admission, severe supraorbital headache, unrelieved by aspirin, lasted for 24 hours and slowly disappeared. Inability to express himself was noted three days before admission. No history of old trauma obtained.

On general physical examination, the findings were normal except for a diffusely enlarged prostate. Neurologic examination revealed aphasia, diminished astereocognostic sense pertaining to the right hand, unequal pupils (the right being larger than the left), diminished tactile sense to pinprick and cotton wool over the right side of the face, slight smoothing out of the lower right face, exaggeration of deep tendon reflexes, particularly on the right side, and positive Babinski, Oppenheim, and Gordon reactions (right).

Examination of the skull showed prominent convolutional markings and some thinning of the dorsum sellæ, the result of increased intracranial tension. Both choroid plexuses were calcified, the right being in normal position while the left appeared

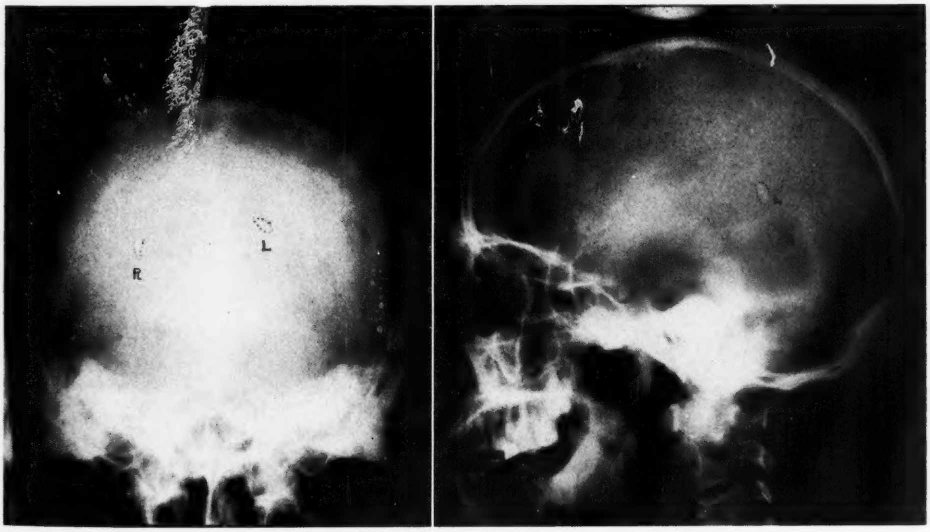

Fig. 4. Case 4. 138,796. S. P. Unverified left posterior intracranial mass in a male subject aged 60 years. Paresis of right arm and leg and aphasia. Displacement of pineal gland 0.8 cm. to the right of the midline. Displacement of left choroid plexus upward, medially, and forward. Refusal of operation by patient. Death occurred at home six months later.

displaced forward and medially two centimeters and upward from one to one and one-half centimeters (Fig. 3). The pineal which fell in normal position on the lateral film was definitely displaced to the right (nearly one centimeter). It was believed these displacements were due to the presence of a large mass in the posterior portion of the left cerebrum. A ventriculogram was attempted, but the left lateral ventricle could not be tapped and this ventricle remained unfilled with air. The right lateral ventricle was markedly displaced to the right and somewhat compressed. Air had passed from the right lateral ventricle to the third ventricle, but the left foramen of Monro was blocked. The third ventricle was not only grossly displaced to the right, but was inclined with its upper position tilting toward the right.

A left temporoparietal craniotomy revealed a massive tumor involving the temporal, parietal, and occipital lobes with surface extension in the temporoparietal region. Section of a portion of the tumor showed a typical histology of a glioblastoma multiforme. A course of deep roentgen therapy followed the operation (4,800 r; four portals 15 × 15 cm. with filtration of 0.5 mm. Cu and 2 mm. Al). An appointment following his discharge was not kept.

Case 4. 138,796. S. P. Unverified left posterior intracranial mass in a male subject 60 years of age. Paresis of right arm and leg and aphasia. Displacement of pineal gland 0.8 cm. to the right of the midline. Displacement of left choroid plexus upward, medially and forward. Refusal of operation by patient, with death occurring at home six months later.

A 60-year-old male Italian entered the Rochester Municipal Hospital on March 29, 1938, with complaint of left frontal headaches of one month's duration, progressive weakness, forgetfulness, and speech difficulties of two weeks' duration. He had become drowsy and experienced frequent hiccups. There was no history of injury. The past history was irrelevant. His neurologic examination was carried out with difficulty due to speech difficulty and aphasia. Fundi showed papilledema bilaterally (2°). The right arm and leg

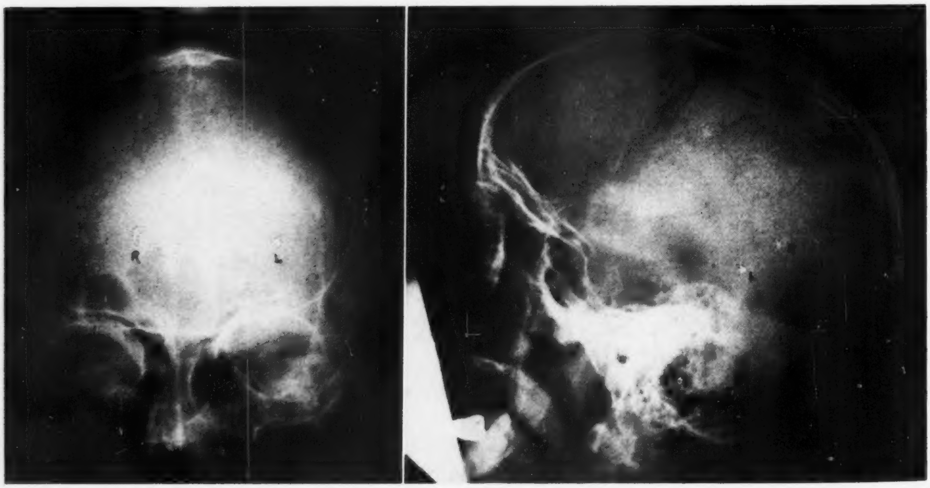

Fig. 5. Case 5. 85,297. J. S. Right posterior cerebral tumor verified by ventriculography in a male subject 54 years of age. Convulsions were explained on basis of acute alcoholism. Alcoholic hallucinosis on first admission. No clinical localizing signs of brain tumor. Discharged from hospital without roentgen examination of the skull.

Re-admission two and one-half months later. Localizing evidence of space-occupying mass on roentgen examination of the skull. Verification of mass by ventriculography. Rapidly ensuing death without operative removal.

TABLE I

	Age (Yrs.)	Location	Pineal Displacement	Choroid Plexus Displacement	Ventriculography
Case 1 132,606 H. E. L.	44	Post-cerebral tumor (left)	Lateral shift only	L—Upward and medial R—Lateral (slight)	Marked shift of lateral and third ventricles to the right without evidence of deformity in anterior portions Unsuccessful
Case 2 133,239 J. Q.	73	Temporal and occipital (left)	Lateral shift only	L—Upward and medial R—Lateral displacement	Confirmed by autopsy
Case 3 105,898 C. K.	61	Temporal parietal and occipital (left)	Lateral shift only (1 cm.)	L—Forward medial and upward R—None	Left lateral ventricle unfilled: right lateral ventricle shifted laterally and compressed: third tilted, upward portion inclining toward right: confirmed by operation
Case 4 138,796 S. P.	60	Posterior cerebral tumor (left)	Lateral shift only (0.8 cm.)	L—Upward, medial and forward R—None	Unconfirmed
Case 5 85,297 J. S.	54	Posterior cerebral lobe (right)	Not visualized on antero-posterior films: lower border of normal zone on lateral film	L—Lateral R—Upward and medial	Right lateral ventricle unfilled: left lateral displaced to the left: third ventricle inclined toward the left with slight arcing

were weaker than the left, the tendon reflexes, abdominal and cremasteric, being decreased on the right side. A slight right lower facial weakness was present under involuntary response.

Roentgenologic examination of the skull showed evidence of increased intracranial tension, prominent convolutional markings over the anterior portion of the skull, particularly over the temporal regions, and atrophy of the dorsum sellæ and posterior clinoids. The pineal was definitely displaced to the right of the midline (0.8 cm.) but fell in normal position on the lateral film. Both choroid plexuses were calcified, the left lying slightly superior and medial and over one centimeter anterior to the right. Calcification was also observed at the base of the skull near the side of the sella, suggesting an arteriosclerotic vessel at the circle of Willis. Operation was advised but refused by the patient who was discharged against advice. He died at home on Sept. 22, 1938 (Fig. 4).

Case 5. 85,297. J. S. Right posterior cerebral tumor verified by ventriculography in a male subject 54 years of age. Convulsions explained on basis of acute alcoholism and alcoholic hallucinosis, on first admission. No clinical localizing signs of brain tumor. Discharged from the hospital without roentgen examination of skull.

Re-admission two and one-half months later. Localizing evidence of space-occupying mass on roentgen examination of the skull. Verification of mass by ventriculography. Rapidly ensuing death without operative removal.

This patient, a 54-year-old laborer, entered the Rochester Municipal Hospital June 19, 1938, with a complaint of recent convulsions (during past two days). He had vomited forcibly and regularly after each breakfast for the two weeks prior to admission. After his admission he was found to be an old alcoholic, and he appeared disoriented and possibly hallucinated. A neurologist found no localizing evidence of a brain tumor. An analysis of his liquor for lead yielded negative results. Physical examination showed evidence of pulmonary emphysema and slight thickening of the peripheral arteries. Examination of spinal fluid yielded no information of value. He was discharged to the neurologic clinic of the Out-patient Department,

without obtaining skull films, with a diagnosis of acute alcoholic hallucinosis.

On re-entry, two and one-half months later, he complained of frontal headaches and persistent drowsiness. On examination he was semi-stuporous, showed indistinct optic nerve heads without choking, and presented deep tendon reflexes which were underactive but equal. The superficial reflexes were lost. The spinal fluid was found to be under increased pressure with slightly increased cellular content (all mononuclears) and with normal reactions except for the Pandy test (2 plus).

Roentgenologic examination of the skull showed normal markings at the inner table, but there was moderate atrophy of the posterior clinoids due to increased intracranial pressure. The calcified choroid plexus of the right lateral ventricle was definitely elevated and displaced slightly medially. The left choroid plexus was not elevated but was displaced slightly laterally. The pineal gland was indistinctly calcified at the lower margin of the normal zone. It could not be visualized on the anteroposterior films of the skull. Diagnostic impression: space-occupying mass in right posterior cerebrum (Fig. 5).

Ventriculography showed air only in the left lateral and third ventricles, the ventricular tap on the opposite side being unsuccessful. The left lateral ventricle was displaced laterally, was moderately hydrocephalic, and showed no localizing defect. The third ventricle was tilted, its upper end inclining toward the left at an angle of 45° with slight arcing. It was evident that the right foramen of Monro was blocked. The diagnostic impression was that of a massive tumor in the right posterior cerebrum, further localization being impossible due to the failure of the right lateral ventricle to fill.

The patient's course following ventriculography was rapidly downhill, with increasing drowsiness and a slow pulse. The tumor was considered inoperable due to the failing condition of the patient; death ensuing the day following the ventriculography.

SUMMARY

Displacement of the choroid plexuses was identified in five cases, four of which were confirmed by ventriculography (the remaining case refused all further diagnostic and therapeutic procedures). There can be little doubt that in this unconfirmed case some form of intracranial mass was present, since we have positive evidence of a grossly displaced pineal gland.

It will be noted (Table I) that all five of the cases showed a common type of displacement of the choroidal plexus on the affected side—upward and medially—and in each case in which ventriculography was carried out, the tumor appeared to be located in the posterior or lateral portions of the cerebral hemisphere (never frontal). In one case in which the presence of the tumor was further verified by operation, the location of the tumor was determined to involve the temporal and occipital lobes and a similar location of the tumor was found in one of the cases coming to autopsy.

In the one case in which the tumor was not verified, there was marked lateral displacement of the pineal and, therefore, there is fair evidence of an intracranial mass. In this case the displacement of the choroid plexus on the affected side was noted to be forward in addition to being medial and upward, suggestive of a very massive tumor (located with much of its bulk in the posterior portion of the cerebrum), probably in the occipital lobe, in addition to involvement of other lobes (parietal and temporal).

All five cases showed a lateral displacement of the pineal, its position falling within normal range in the other two planes of space. When this finding is combined with that of the displaced choroid plexus (upward and medially), the evidence of a large tumor located in the posterolateral position of the affected cerebral hemisphere becomes very strong. This combination of findings would appear to be sufficient to rule out a tumor arising within the anterior or frontal portion. It also indicates a very massive tumor, and it is quite

probable the neurosurgeon should weigh well the chances of operative removal in contemplating surgical interference.

It is quite probable that, if both the pineal and the affected choroid plexus are displaced in the manner described, ventriculography is not required in order to determine either (1) the presence or absence of an intracerebral mass, or (2) its general location as regards its extent (the remaining evidence valuable to the neurosurgeon and generally attainable by ventriculography). One may be assured that it is massive in its growth, involving multiple lobes of the brain though it undoubtedly is true that its exact ramifications remain unknown. Will ventriculography add any information of value? It did not in those cases in which it was tried in this brief series. The ventricle of the affected side could not be successfully tapped and remained unfilled by air. This, of necessity, precluded any outlining of a local defect. The ventriculograms have supplied us only with data already obtained by simple radiography of the skull, namely (1), a lateral shifting of the pineal (third ventricle by ventriculography), and (2) displacement of choroid plexuses (lateral ventricles by ventriculography). In fact, ordinary skull radiographs have given us more information regarding the position of the lateral ventricle of the affected side than did ventriculography, because of the failure of the ventricle on this affected side to fill, while the direction and extent of the displacement of the glomus of the lateral ventricles were obtained from a simple analysis of the skull film.

CONCLUSIONS

1. Displacement of the choroid plexuses may occur as the result of an intracerebral mass.

2. Displacement appears to be dependent on (1) the location of tumor in posterolateral aspect of the cerebrum, and (2) the massive character of growth.

3. The discovery of a displaced choroid plexus appears to be adequate to rule out a primary tumor in the frontal region without resorting to ventriculography.

4. The displacement of the choroid plexus was associated with a lateral shift in the position of the pineal gland in all cases in which the pineal was visualized on the anteroposterior film.

5. It is quite probable that the combination of a displaced pineal gland and a choroid plexus is adequate not only to lateralize the region but to limit its location to the posterolateral portion of the cerebrum.

6. The choroid plexus of the contralateral ventricle may show evidence of a shift, but this is not as marked as in the involved side and is limited to a shift in the lateral direction.

7. Ventriculography was performed with difficulty in this series. The displacement and collapse of the posterior portion of the ventricle prevented successful tapping on the involved side.

8. If careful search for the position of the choroid plexuses is made in every examination of the skull, it is believed that displacement of these plexuses will be found more frequently in the future, since the five cases herein reported were all identified during a single twelve-month period.

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ANALYSIS OF LAMINAGRAPHIC MOTIONS AND THEIR VALUES[1]

By JEAN KIEFFER, *Uncas-on-Thames, Norwich, Connecticut*

INTRODUCTION

THE addition of body-section roentgenography to other diagnostic procedures has definitely enlarged the scope of roentgenologic diagnosis and this new method has already proven useful in many cases. The cardinal principle of body-section roentgenography is that the tube, film, and the body to be roentgenographed shall be in relative motion to one another during exposure.

Recently, a variety of apparatus and technics has been presented under different names by various authors: namely, stratigraphy (Vallebona,15); tomography (Grossmann, 8); planigraphy (Ziedses des Plantes, 18, Andrews, 1); x-ray focusing, vertigraphy (Kieffer, 9); laminagraphy (Kieffer-Moore, 10). (The last method has also been spelled "laminography" by various authors.) Andrews in his original paper called attention to this multiplicity of names and recommended definite uses for them. In order to avoid confusion, and until an official terminology is decided upon, I suggest the following extended classification, based upon his recommendations, to which I shall adhere in this paper.

1. *Body-section Roentgenography.*—The generic term for a method permitting the roentgenographic visualization of selected objects in a body by eliminating or minimizing by blurring shadows of other objects which otherwise would interfere with visualization. This includes all the methods heretofore mentioned.

2. *Stratigraphy.*—A method whereby body-section roentgenography is accomplished by relative motion of the tube and film with respect to the body roentgenographed, the tube and film meanwhile having no motion relative to one another. This can be accomplished by rotating the body between a stationary tube and film (Vallebona's, 15, original stratigraph, Fig. 1, Method 1), or by moving the tube and film around the stationary body (Method 4 of Andrews, 1; Bartelink's, 4, apparatus; Vallebona's, 16, improved stratigraph, Fig. 1, Method 2).

3. *Tomography.*—A method whereby body-section roentgenography is accomplished by motion of the tube and film along concentric[2] segments of arcs, the film surface meanwhile maintaining its orientation with respect to the body roentgenographed (Method 6 of Andrews, 1; apparatus of Grossmann, 8, and its modification of Andrews and Stava, 2; Fig. 1, Method 3).

4. *Planigraphy.*—A method whereby body-section roentgenography is accomplished by motion of the tube and film along planes parallel to each other and to the film surface (Methods 1 and 2 of Bocage, 5, and Andrews, 1; apparatus of Portes and Chausse, 11, Ziedses des Plantes, 18, Kieffer, 9, Twining, 14, and their modifications; Fig. 1, Method 4).

5. *Vertigraphy.*—A method whereby body-section roentgenography is accomplished by motion of the tube and film in planes parallel to each other and perpendicular to the film surface (Kieffer, 9; Fig. 1, Method 5).

6. *Laminagraphy.*—A method whereby body-section roentgenography is accomplished by motion of the tube and film in planes parallel to one another and at any angle to the film surface (Kieffer-Moore, 10; Fig. 1, Methods, 4, 5, and 6).

Thus, according to these definitions, it will be seen that planigraphy is only a special case of a more general method or,

[1] Read in abstract form at the Twenty-fourth Annual Meeting of the Radiological Society of North America, at Pittsburgh, Nov. 28–Dec. 2, 1938.

[2] These segments are concentric only for a limited portion of the film surface but all have their centers at the plane parallel to the film surface which contains the pivotal point of the system (plane in focus).

conversely, that laminagraphy is a more general method of which planigraphy is only a special case. The present usage of the words seems to justify this classification.

It will also be seen that tomography, according to this scheme, is not considered a laminagraphic or a planigraphic method. Although tomography gives results very similar to, and quite as valuable as, a particular planigraphic method (rectilinear planigraphy) the mechanical system it uses

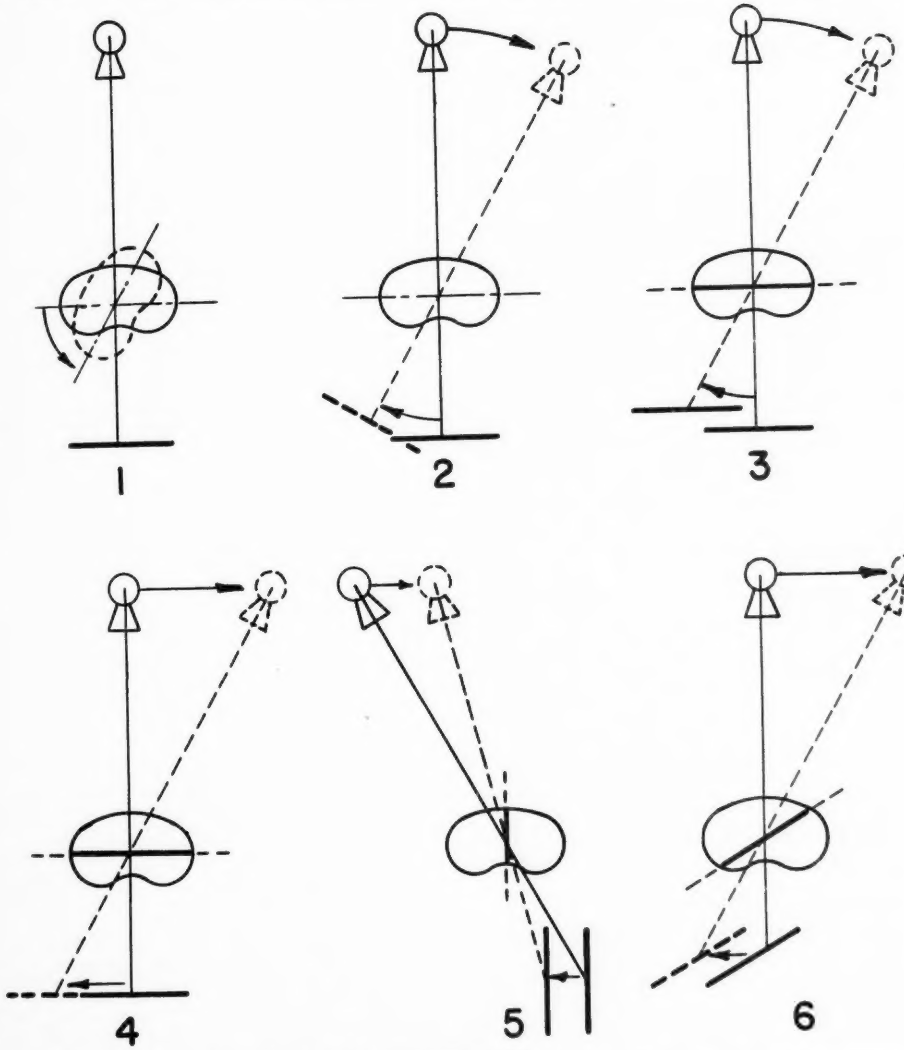

Fig. 1. Basic methods for body-section roentgenography.
Methods 1 and 2, Stratigraphy. The relative motion between the tube and film and the body are essentially similar.
Method 3, Tomography. Tube and film may move along any portion of concentric circles. The relative position of the tube, body, and film determines the plane visualized which is always parallel to the film surface.
Methods 4, 5, and 6, Laminagraphy. Tube and film may move along any portion of parallel planes. In the planigraphic Method 4 the film surface is parallel to the planes of motion of the tube and film while in the vertigraphic Method 5 it is at right-angles to them. Both are special cases of Method 6 (illustrated as for oblique laminagraphy) where the film surface may be at any angle to the planes of motion. In all cases, the plane visualized is parallel to the film surface.

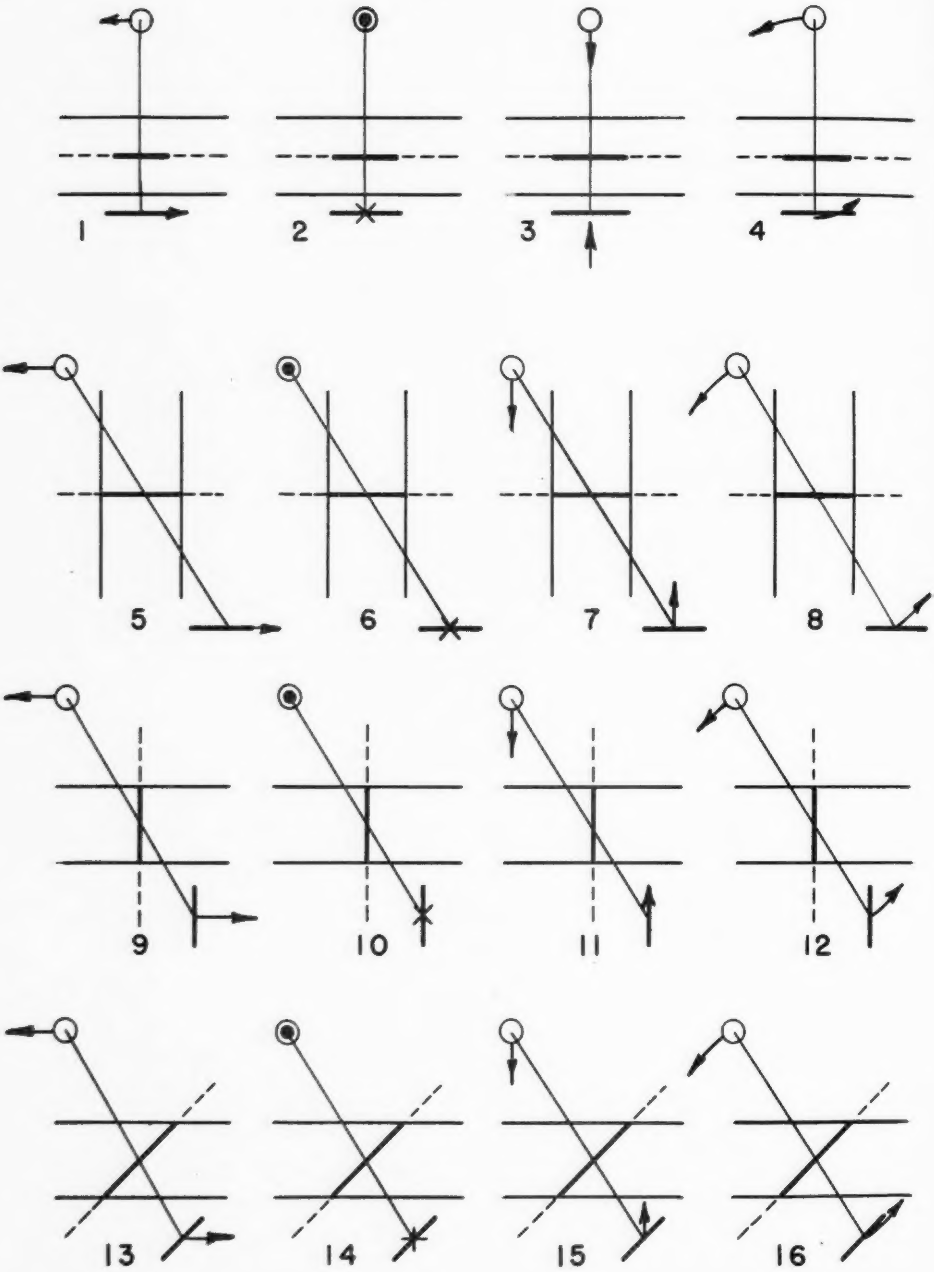

Fig. 2. Relative motions for roentgen visualization of body layers. (The circle with central dot and the cross (second column) indicate motions toward and away from the observer, respectively, in directions perpendicular to the plane of the paper.)

The first series (Systems 1 to 4) shows the tube and film directly over and under, the plane wanted. The second series (Systems 5 to 8) shows decentering to each side, thus permitting visualization of planes at right-angles to a body axis longer than the target film distance. The third series (Systems 9 to 12) shows the film turned at right-angles to the position shown in the second series. The fourth series (Systems 13 to 16) shows

is quite different from that used in laminagraphy or planigraphy and does not always permit of the same analysis. It is for these reasons, which will become more apparent later, that I suggest its classification apart from planigraphy or laminagraphy.

The method which I have called vertigraphy does not prove as practical for ordinary body-section roentgenography as the planigraphic method. However, in a previous paper (9) I have pointed out that for certain results, particularly for visualization of planes at right-angles to the long axis of a body, this method becomes very valuable. This method is part of the very definite extensions of the planigraphic method described in the same paper. It is these extensions (visualization of planes at right-angles or at any angle to the long axis of the body), as well as the planigraphic method, which form the more general method of laminagraphy.

I wish to confine this paper to the discussion of methods capable of representing a true plane or a plane layer of limited thickness because they are the most valuable ones. The stratigraphic method does not do this but, instead, produces only a "zone" of adequate definition limited in thickness and width; therefore it will not be discussed any further here, particularly as it has already been thoroughly analyzed by Vallebona.

A true plane can be visualized only when, during exposure, the film surface does not change its orientation relative to the body roentgenographed. A very large number of relative motions of tube and film may be used to accomplish this purpose (Fig. 2). In all of them the essential requirement is that the tube and film move in directions at all times opposite to one another and with displacements proportional to the distance of the target to the plane to be roentgenographed and of the distance of that plane to the film, *i.e.*, with velocities at all times opposite and proportional to one another. The path taken during exposure by the target, and consequently by any point on the film, may be of any orientation or shape (Fig. 3). Theoretically, no matter

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the film turned at any angle. In all cases the plane visualized is parallel to the film surface. There are only two basic motions: the tube and film move in a plane parallel to the film surface (Systems 1 and 2) or at right-angles to it (System 3). In System 1 the motion is along the plane of the paper, in System 2, at right-angles to it. All other motions are either similar to them or compound motions which can be reduced analytically to the components shown in the first three systems. The various relative motions possible fall into the following classes:

- Rectilinear Laminagraph
  - Rect. Centered Laminagraph
    - Rect. Centered Planigraph: Systems 1, 2, and 14.*
    - Rect. Centered Vertigraph: System 3.
  - Rect. Decentered Laminagraph
    - Rect. Decentered Planigraph: Systems 5, 6, 10, 11, and 14.
    - Rect. Decentered Vertigraph: Systems 7 and 9.
  - Rect. Oblique Laminagraph: Systems 13 and 15.
- Tomograph (These systems are essentially similar to one another and are combinations of the extensions of the basic Motions 1 and 3.)
  - Centered Tomograph: System 4.
  - Decentered Tomograph: Systems 8 and 12.
  - Oblique Tomograph: System 16.
- Compound** Laminagraph
  - Comp. Centered Laminagraph
    - Comp. Centered Planigraph: System 1+2.
    - Comp. Centered Vertigraph: Systems 1+3 and 2+3.
  - Comp. Decentered Laminagraph
    - Comp. Decentered Planigraph: Systems 5+6 and 10+11.
    - Comp. Decentered Vertigraph: Systems 9+10, 9+11, 6+7, and 5+7.
  - Comp. Oblique Laminagraph: Systems 13+14, 13+15, and 14+15. (These are also similar to Systems 2+13, 3+13, 1+14, 3+14, 1+15, and 2+15.)
- Compound Tomograph
  - Comp. Centered Tomograph: System 2+4.
  - Comp. Decentered Tomograph: Systems 6+8 and 10+12.
  - Comp. Oblique Tomograph: System 14+16.
  - Spherical Tomograph: Combination of System 4, 8, 12, or 16 with a similar motion at right-angles to them, resulting in motion of the tube and film along sections of spherical surfaces.

* System 14 falls in this class if a normal to the film surface passes through the film center at the middle point of target motion.

** If the resulting motion is rectilinear, these systems remain rectilinear laminagraphs.

what the orientation of this path, only one plane will be sharply recorded on the film (plane in focus) and that plane will be the same for all motions. It is the plane parallel to the surface of the film and which contains the pivot point of the system. This point is stationary relative to the body roentgenographed and may be either actual or theoretical.

It must be realized that the shape of the target path controls the shape of the path travelled on the film by the shadows of points not at the plane of focus. The shadows of all points in the plane of focus have no displacement on the film and are recorded similarly, whatever motion is used, but all points above and below have a displacement on the film of configuration similar to that of the target path, but of size varying with the distance of these points to the plane of focus. This means that the moving shadows of all objects not in the focal plane produce recorded shadows of varied appearance which are superimposed on the unvarying shadow of the plane in focus on the film.

Actually, the configuration of the path travelled by point shadows on the film surface is similar to the *projected* path of the target on a plane parallel to the film surface. This projected path is identical with the actual path if the target motion is limited to a plane parallel to the film surface (planigraphic method).

The tomograph of Grossmann does not exactly fit this description, but the projected path of its arcuate target travel is a straight line, or a nearly straight line, and the practical results obtained with it are so similar to those obtained with unidirectional (rectilinear) motion that some analysis of its motion will be included in this discussion.

The image recorded on a roentgenograph obtained by any laminagraphic or tomographic method can be considered as composed of two parts: first, the sharp image of the plane which has no motion on the film, and which consequently is similar for all methods (disregarding, for the present, mechanical limitations); second, the blurred images of the planes above and below the plane in focus which are not completely eliminated (residual shadows) and, therefore, are still a hindrance to perfect visualization of the plane wanted. The appearance of these blurred images depends on the path on the film of the shadows which form them, and the difference in the appearance of such roentgenographs is due mainly to these residual shadows. The less objectionable these shadows, the better the diagnostic value of the roentgenographs; thus the "quality" of body-section roentgenographs is mainly dependent on the path followed by the target, *i.e.*, the type of motion used.

The application of body-section roentgenography to practical diagnostic problems is dependent, therefore, upon an ade-

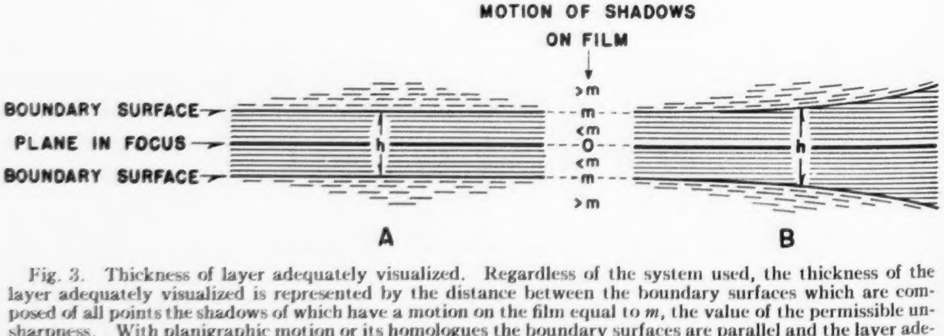

Fig. 3. Thickness of layer adequately visualized. Regardless of the system used, the thickness of the layer adequately visualized is represented by the distance between the boundary surfaces which are composed of all points the shadows of which have a motion on the film equal to m, the value of the permissible unsharpness. With planigraphic motion or its homologues the boundary surfaces are parallel and the layer adequately visualized, or depth of focus h, is the same for all points (Diagram A). However, with systems having a vertigraphic component such that the perpendicular distances of the target to the film surface are not equal when the tube is at the extreme points of its maximum displacement, the depth of focus h varies from points to points (Diagram B).

quate understanding of the effect of the type of motion used. The development of satisfactory technics also depends upon the practical limitations (mechanical, technical, and economical) of a suitable apparatus.

ANALYSIS

A critical analysis of laminagraphic motions must take into consideration the following factors:

(1) Theoretical effect, assuming perfect apparatus and technics.

(2) Mechanical limitations.

(3) Technical limitations.

(4) Economical limitations.

A preliminary general discussion of these factors will assist in a detailed critical study of the various types of motion, so each factor will first be considered generally for all motions, then each motion will be critically analyzed for each factor.

General Theoretical Effect.—Let us consider the end-results. I have stated in the introduction that the image recorded on a film during laminagraphic exposure may be divided into two parts: first, the sharp image of the plane having no motion on the film (plane in focus); second, the blurred images of all the planes above and below.[3] This is true only under theoretically perfect conditions: that is, a perfectly motionless object; a mechanical system perfectly aligned and without lost motion; an x-ray tube with a "geometrical point" target; a sensitive surface, film base (emulsion and screens) perfectly plane, without thickness, and capable of infinite resolution, and a perfect "eye" to see the results.

These conditions are never realized. Because no part of a laminagraphic image has absolute sharpness and no clear-cut difference exists between the plane in focus and the adjacent planes, the section clearly visualized is not a true plane, but a layer of appreciable thickness. This thickness depends on a variety of factors. It may be considered as the thickness of the section which is recorded in such a way that adequate information can be derived from it, and may be called the "depth of focus."[4]

[3] Van der Plaats (17) has made an interesting theoretical analysis of this, although his conclusions do not seem warranted by the facts.

[4] It is really the "depth of field in focus" and, in optical terminology, would be called the "depth of field."

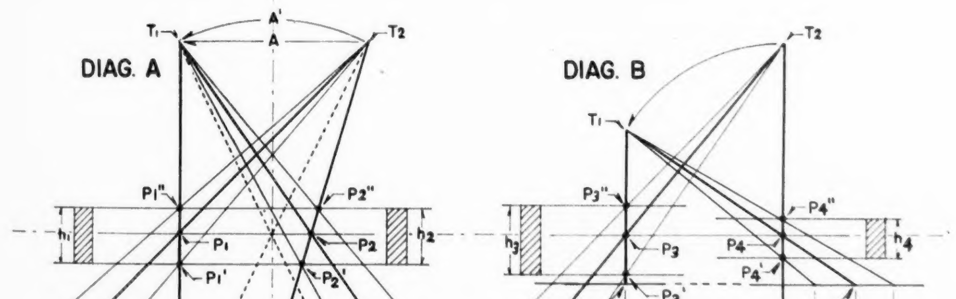

Fig. 4. Thickness of layer in focus. T_1 and T_2 are the end points of the target travel. When they are equidistant from the film surface, as in Diagram A, the shadows of points P_1 and P_2 in the plane in focus are displaced with the film surface the equal distances M_1 and M_2, while the target is displaced from T_1 to T_2. The boundary of the layer in focus is formed by points the shadows of which have a displacement on the film equal to the value of permissible blurring m. Such points are P_1' and P_1'', and P_2' and P_2'', therefore the distances h_1 and h_2 represent the thickness of the layer in focus at points P_1 and P_2. It is evident from the diagram that h_1 and h_2 are equal and it is proved by mathematical analysis (see explanation of Figure 5) that the value of h is the same for all points of the plane in focus. This is true whether the target and film have followed the planigraphic path A and a or the tomographic path A' and a'. When the target path is such that the ends of the path are not equidistant from the film surface, the depth of focus is not uniform. This is shown in Diagram B where the distances h_3 and h_4, representing the value of the depth of focus for blurring m at points P_3 and P_4, respectively, are not equal. However, the plane in focus is still parallel to the film surface.

It is that thickness which is represented on the film within a "maximum unsharpness consistent with adequate visualization," or "permissible unsharpness." In practical work this permissible unsharpness varies with the information sought. For this discussion of the general theoretical effect we will consider this unsharpness due entirely to the laminagraphic motion of a perfect system. The other factors will be evaluated later.

If, in such a system, the theoretical blurring of the images of points not in the plane of focus is regarded as equal to the maximum displacement of their images on the film surface, all points whose images are displaced on the film by an amount smaller than the value of any permissible unsharpness chosen will be within the layer of focus, to the exclusion of all others. This layer will extend on each side of the theoretical plane in focus, and the thickness of the layer will be the distance between the boundary surfaces of the layer taken normal to the surface of the plane in focus at any point (Fig. 3).

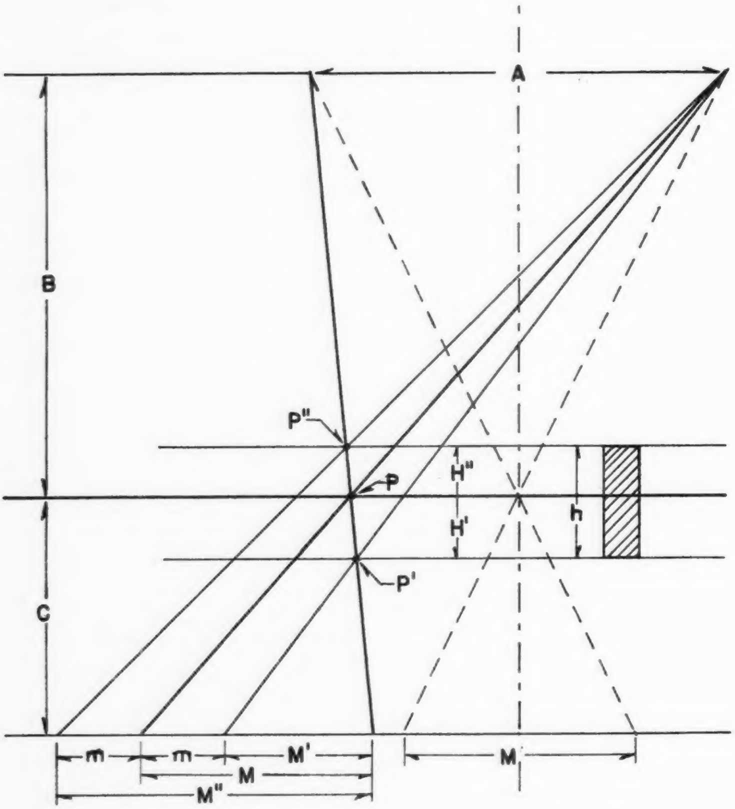

Fig. 5. Value of depth of focus. P is any point along the plane in focus. Its shadow on the film (as well as the film) are displaced in space the distance M while the target travels the distance A. The points the shadows of which have a displacement m on the film (see explanation of Figure 4) are, therefore, those whose shadows have a spatial displacement along the film surface plane of $M - m$ and $M + m$. Such points are P' and P''; the sum of their distances from the plane in focus, H' and H'', respectively, gives the value of the depth of focus h. For further explanation, see text.

Thickness of Layer in Focus.—The thickness of the layer in focus does not vary from place to place if the motion used is such that the boundary of the target path remains in a plane parallel to the film surface. When the boundary of the target path is not in a plane parallel to the film surface, there usually is a maximum thickness where the axis of greatest amplitude meets the film surface.[5] The remainder of this paper will be confined to the systems which result in a layer in focus of uniform thickness. All the planigraphic systems belong to this class, because by definition the target path is at all times parallel to the film surface. The tomograph, as ordinarily used, belongs to it also. As long as a tomograph has a motion which brings the target an equal distance from the film surface at the beginning and end of the motion, and a tangent to the arc described by the target does not impinge on the film, the boundary of its target path will be parallel to the film surface so that it will also produce a layer of uniform thickness (Fig. 4). It then resembles a planigraphic system, the target-film distance and pivot-film distance of which are the same if the measurements are taken at the *limits* of the tomographic motion and *perpendicular* to the film surface. Under these conditions, it is practically a homologue of a planigraphic system using rectilinear motion, and the same analysis applies.

Determination of Depth of Focus for Planigraphic Systems or their Homologues.—Because the depth of focus for such systems is uniform throughout we may determine its value at any convenient place. Taking a point directly under one of the limits of amplitude (Fig. 5) we see that the shadow of point P, as well as the film surface, has a motion in space equal to M, while the target travels from T to T'. If we take m as the value of permissible blurring, we find that points the shadows of which have a motion in space of $M - m$ and $M + m$ will be the points determining the limit of the depth of focus h. Such points will be at P'' above P and at P' under P and the sum of their distance H'' and H', respectively, will give the value of the depth of focus. We then have,

$$h = H' + H'' \tag{1}$$

$$m = M - M' \text{ and } m = M'' - M \tag{2}$$

but from the diagram,

$$M = \frac{AC}{B},\ M' = \frac{A(C - H')}{B + H'},$$
$$\text{and } M'' = \frac{A(C + H'')}{B - H''} \tag{3}$$

and from Equations 2 and 3,

$$m = \frac{AC}{B} - \frac{A(C - H')}{B + H'} \text{ from which}$$
$$H' = \frac{mB^2}{A(B + C) - Bm} \tag{4}$$

Similarly,

$$H'' = \frac{mB^2}{A(B + C) + Bm} \tag{5}$$

and

$$h = \frac{mB^2}{A(B + C) - Bm} + \frac{mB^2}{A(B + C) + Bm} \tag{6}$$

Since P was taken as any point and since this equation does not contain the co-ordinates of P but only the constants of the system, the value of h will be the same for any other points no matter where located along the plane in focus, therefore, for a planigraphic system or its homologue the depth of focus is uniform.

Equation 6 can be simplified for its practical application. For small values of m, Bm is so small in comparison with $A(B + C)$ that it can be disregarded, particularly as it nearly cancels in two parts of the equation, and

$$h = \frac{mB^2}{A(B + C)} + \frac{mB^2}{A(B + C)} = \frac{2mB^2}{A(B + C)} \tag{7}$$

It can be seen that the depth of focus for any given system varies directly as the permissible blurring and inversely as the amplitude, and that it is not the same for varying pivot heights, even if the amplitude remains the same (see Table I).

[5] The axis of greatest amplitude is coincident with the line joining the two points of the target path which are separated by the greatest distance.

This equation indicates a most important fact: the depth of focus decreases as the amplitude increases. A doubled amplitude means a halved depth of focus.

General Theoretical Effect of Type of Motion on Blurring.—We also see from the diagram or from Equations 2 and 3 that the blurring for any given point above or below the plane in focus is directly proportional to the amplitude and that if the amplitude is reduced to zero there will be no blurring. This assumes great importance when we consider any motion of target and film as composed of two components at right-angles to one another (Fig. 6). In rectilinear motion the component at right-angles to the motion equals zero so that for this type of motion there can be no component of blurring at right-angles to the direction of the target motion. Consequently, if instead of considering only the depth of focus for maximum blurring in any axis, we also consider the depth of focus for each component of motion along other axes, we find that the theoretical depth of focus for rectilinear motion is infinite for axes at right-angles to the direction of motion. Therefore, elongated objects oriented along the direction of such motion will have blurring in detail throughout but will have no blurring of the *outline* parallel to the motion. In other words, a line of limited length so oriented will only be blurred at the end and still will appear as a line just as sharp as if it were at the plane in focus. If the direction of rectilinear motion coincides with part of the outline of an elongated anatomical structure, it may still be so sharply defined that its residual shadows will be hard to differentiate from outlines of objects at the plane in focus.

For any laminagraphic motion in general, maximum blurring occurs along the axis of greatest amplitude and minimum blurring along the axis perpendicular to it. The relative values of the blurring along any axis are proportional to the components of target motion along that axis. The appearance of the residual shadows of objects not at the plane in focus depends on their orientation relative to the axis of greatest amplitude unless the components

TABLE I.—LAMINAGRAPHIC TECHNIC

Table of Depth of Focus in Millimeters (Theoretical)

(For target-film distance of 75 cm. (approximately 30 in.) and film-table top distance of 3 cm.)

Depth of Focus in Millimeters to the Nearest 0.1 Millimeter												
For Permissible Blurring of 0.3 mm.						Pivot Height above Table	For Permissible Blurring of 1.0 mm.					
Amplitude in cm.							Amplitude in cm.					
60	45	30	20	10	5		5	10	20	30	45	60
mm.	mm.	mm.	mm.	mm.	mm.		mm.	mm.	mm.	mm.	mm.	mm.
0.69	0.92	1.38	2.07	4.14	8.28	0	27.6	13.8	6.9	4.6	3.1	2.3
0.66	0.87	1.31	1.97	3.94	7.86	2	26.2	13.1	6.6	4.4	2.9	2.2
0.60	0.80	1.20	1.80	3.60	7.20	5	24.0	12.0	6.0	4.0	2.7	2.0
0.51	0.69	1.02	1.53	3.06	6.12	10	20.4	10.2	5.1	3.4	2.3	1.7
0.43	0.58	0.87	1.30	2.61	5.22	15	17.4	8.7	4.3	2.9	1.9	1.5
0.36	0.48	0.72	1.08	2.16	4.32	20	14.4	7.2	3.6	2.4	1.6	1.2

Based on approximate formula $h = \frac{2mB^2}{A(B + C)}$

where m = permissible blurring
A = amplitude
B = distance of target plane to plane in focus
C = distance of plane in focus above film
$B + C$ = target plane to film plane distance (target-film).

The table for one millimeter can be used to calculate depth of focus for any other permissible blurring by multiplying the values shown by the size of permissible blurring in millimeters.

Example: Wanted—value of depth of focus at 10 cm. pivot height, amplitude 20 cm., and permissible blurring of 0.3 mm.

From the table, value for 1 mm. = 5.1; wanted value = $5.1 \times 0.3 = 1.53$ mm. which checks with the other table.

of motion are equal or nearly equal, as in circular or spiral motion.[6] The effect of any particular motion will be considered later.

General Mechanical Limitations—Lost Motion.—The most important mechanical limitation is that of lost motion. The target and film move at all times with motions reciprocal and proportional to each other; (2) that the film surface does not change its orientation. Any lost motion will affect the ratio of displacement of target and film and all mechanical systems used for this purpose must have some lost

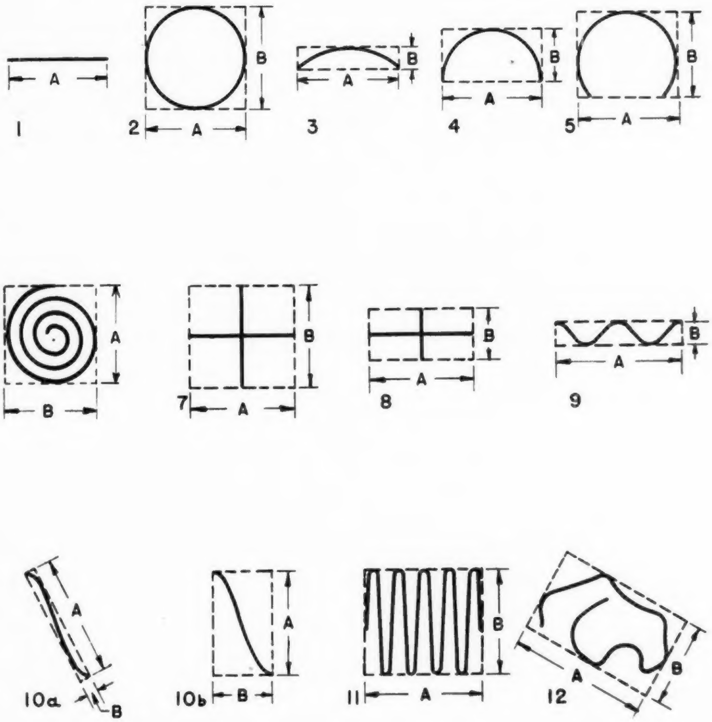

Fig. 6. Component of amplitude for various motions. *A* represents the component along the axis of greatest amplitude, *B* the component at right-angles to it. These components determine the degree of blurring of the residual shadows and the shape of the path determines the quality of this blurring. (1) Straight line (also segment of arc perpendicular to film surface): *A* coincides with path, value of *B* equals zero. (2) Circle: *A* and *B* are any diameters perpendicular to one another. (3), (4), and (5) Segments of circle parallel to film surface. (6) Spiral: *A* is the diameter passing through the distal end of the spiral, *B* the diameter at right-angles to it; practically, the envelope may be considered circular and any diameter taken. (7) Square cross: either leg may be considered for *A* or *B*. (8) Rectangular cross: *A* is coincident with the longest leg. (9) Elongated repeated sine. (10) Elongated half sine: the value of the components of amplitude are as shown by (10a), not as indicated by (10b). (11) Closely repeated sine. (12) Any shape path: *A* is equal to the longest line possible to inscribe within the path.

prime requisites of an apparatus for body-section roentgenography are (1) that the motion. This amount might be infinitesimal, but no part can move without some clearance. The greater the number of links and movable points of attachment, the greater the lost motion will be because

[6] For a more extended explanation and illustrations reference should be made to the author's original paper (9).

the amount of motion lost at different points of attachment will be cumulative in most instances. Everything else being equal, the simplest mechanical system will have the least amount of lost motion.

A tomographic system is the simplest system possible and its superiority from that standpoint is unquestionable. There is no movable point of attachment between the target and the main link, only one between the tube end and the film end of this link, and one where the film-holding structure is attached to this link. In a planigraphic or laminagraphic system there are more moving points of attachment and consequently there is more lost motion. However, there will be no apparent difference in the results if that lost motion is kept

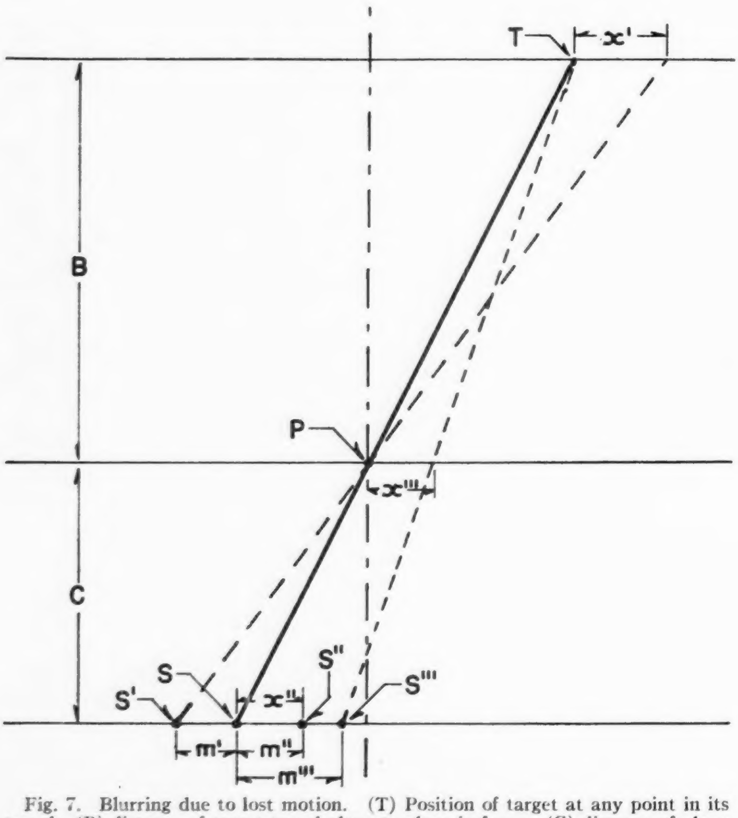

Fig. 7. Blurring due to lost motion. (T) Position of target at any point in its travel; (B) distance of target travel plane to plane in focus; (C) distance of plane in focus to film surface; (P) any given point in plane in focus; (S) shadow of point P on film surface, with target at A and system at rest. When there is no lost motion the shadow of P will always coincide with the point S on the film surface, no matter where T may be displaced. Lost motion, represented by X' between the target and pivot rod, permits the position of the shadow of P to vary on the film from S to S' and the blurring m' equals $X'C/B$. Lost motion represented by X'' between the film support and the pivot rod permits the position of the shadow of P to vary from S to S'' and the consequent blurring m'' equals X''. Lost motion represented by X''' at the pivot plane permits the shadow of P to vary from S to S''' and the consequent blurring m''' equals $X''' (B + C)/B$. In ordinary practice B is always much greater than C and these formulas show that the blurring effect of lost motion is amplified at the pivot plane, while it is minimized if it occurs at the target plane and unaffected if it occurs at the film plane.

within the limit of visibility. There is also the possibility that a difference in the ratios of displacement of target and film will be caused by the "whip" of moving parts due to inertia forces. However, any "lost motion" or "whip" present in the driving mechanism causes only deviations in the prescribed target path and does not affect the results, because these deviations are proportionally transmitted between the tube and film by the main link, or "pivot rod," connecting them. But the rod itself must have no appreciable whip and the sliding points of attachment no appreciable lost motion. The only mechanical defects which have any effect on the results are those which alter the position of the target or film with regard to the pivot rod.

For any planigraphic system the blurring due to mechanical limitations is greatest when the lost motion or whip occurs at the level of the plane in focus (Fig. 7). Because it is easiest to eliminate lost motion at this plane (the pivot point is fastened to the table structure), the blurring due to mechanical limitations can easily be kept within satisfactory limits, as has been shown by the results obtained with such equipment.

A change in orientation of the film surface *during motion* causes a similar change in the orientation of the plane in focus *during motion*. If this change in orientation keeps the plane in focus within the limits of the depth of focus, the resulting blurring is negligible. This is easily accomplished with any equipment, perhaps more easily with a planigraphic apparatus than with a tomographic one, because in the former the film-supporting structure moves on a straight track while in the latter a linkage system is used. If the length of the link used in the tomograph is not exactly the same as the distance between the pivot point of the system and the pivot point of the film-supporting structure, exact parallelism will not be maintained. In any case, the slight loss of parallelism which may occur in a well designed equipment is negligible. However, when some "simple attachments" are used, this loss of parallelism may be great enough to cause appreciable blurring in the plane in focus.[7]

It is to be noted here that any lack of parallelism between the film surface and the target-travel plane, which remains constant during motion, will not of itself cause blurring of the plane in focus; it will cause only a change in the location and orientation of the plane in focus. But a lack of parallelism between the target-travel plane and the film-pivot travel plan will "skew" the plane in focus into a curved surface[8] and also cause blurring within the zone of sharpest focus. If the amount of the lack of parallelism at the limits of amplitude is less than the depth of focus, it will have no appreciable effect on the planeness or sharpness of the layer in focus.

These are the mechanical limitations inherent in any system in which the tube and film move during exposure. Limitations due to size of target, thickness of film, etc., are better classified under technical limitations.

General Technical Limitations.—The technical limitations which affect laminagraphic technics differently from conventional ones are:

(1) Size of target.[9]

(2) Thickness of screens and film.

(3) Problems of elimination of secondary radiations.

(4) Variations of target-film distances during motion.

(1) *Size of Target.*—The projected size of the tube target limits the amount of detail it is possible to obtain on a body-section roentgenograph, just as it does on a conventional roentgenograph. However, this limitation assumes a somewhat different importance in the former technic. The

[7] The lengthwise sagging of some tables from which the Potter-Bucky carriage is suspended is often great enough to affect the results.

[8] Mathematical exposition is too involved to be given here.

[9] "Target" is henceforth used as synonymous with "place of emission" to avoid the confusion that "focal spot" might cause in conjunction with laminagraphic discussion.

projected size of the target depends on three factors: (*a*) its width, (*b*) its height, (*c*) the angle it makes with the film surface. The normal projected rating for a target is given as the size obtained when projected perpendicularly on the film surface with the axis of the tube parallel to the film surface. That is, this rating gives the actual projected size for only one point on the film: the point perpendicularly under the center of the target. With small film and long target-film distance, and with the tube directly over the center of and parallel to the film, the difference of the projected size at various places on the film will be small and negligible, but will become appreciable when short target-film distances and large films are used and the tube is not directly over the center of the film.

The following sizes of projected areas are for 14 × 17 in. (35.5 by 43.2 cm.) film with a target of 2 × 2 mm. rated projected area centered 75 cm. above it and with an anode angle of 20°.

(*A*) With the target facing a 14-inch side:	
at center	2.0 × 2.0 mm.
at middle of short side facing target	3.6 × 2.0 mm.
at corners of short side facing target	3.6 × 3.3 mm.
at middle of short side toward target heel	0.4 × 2.0 mm.
at corners of short side toward target heel	0.4 × 3.3 mm.
(*B*) With the target facing a 17-inch side:	
at center	2.0 × 2.0 mm.
at middle of long side facing target	3.3 × 2.0 mm.
at corners of long side facing target	3.3 × 3.6 mm.
at middle of long side toward target heel	0.7 × 2.0 mm.
at corners of short side toward target heel	0.7 × 3.6 mm.

Actually, the values are somewhat higher at the corners of the film because there also occurs some distortion for points not directly in front, in back, or to one side of the target. During laminagraphic motion when the tube is decentered one way and the film another, the discrepancy becomes even greater. When a point on the film comes in a line with the face of the target, the projected area becomes infinitely small and all points beyond are in the shadow of the anode heel and receive no radiation whatever. In fact, if the tube is not rocked during motion, the shadow of the anode heel will cover points beyond 15 cm. from the film center when the motion has displaced the anode 10 cm. in a direction forward to the face of the target in a system using a 75 cm. target-film distance and a pivot height of 10 cm. The shadow of the tube mounting will similarly affect the film area receiving radiation. However, the shadow of the heel or tube mounting will be on the film for only a short part of the motion and unless a large film or large amplitude is used the slight under-exposure will not be very noticeable. But when the limit of amplitude toward the heel of the target is reached and the target is at its maximum displacement at right-angles to that position, the projected target area on the film will have a maximum value. For the case cited above (target 10 cm. from film center, T.F.D. 75 cm., pivot height 10 cm.), the projected area at the corner of a 14 × 17 in. film the long way will be about 5 × 5 mm., and at the corner of an 8 × 10 in. film, about 4 × 4 mm., instead of about 4 × 4 mm. and 3 × 3 mm., respectively, when the tube is at center. In the above case, a 5 × 5 mm. size of projected area *on the film* causes a blurring of approximately 0.7 mm. However, rocking the tube so that its central ray remains pointing to the center of the film keeps the projected target area at a smaller value. It is also to be remembered that the maximum projected area is at any given part of a film only for a relatively short part of the exposure, so that the general effect of blurring due to this cause will actually be less than indicated by the figures given above. However, a full analysis of laminagraphic motion cannot disregard the fact that there is an increased blurring when the tube is not kept centered on the film. This increased blurring is very small if the plane in focus is near the film surface or if a small target or a small film is used and can then be disregarded; but if the plane in focus is at a relatively long distance above the film surface (10 to 20 cm.), the added blurring may become appreciable, particularly if

tubes with large targets are used to cover large films.

Another limitation due to the material size of target just described, but its result is to give an equal blurring to points not far distant from one another in a direction

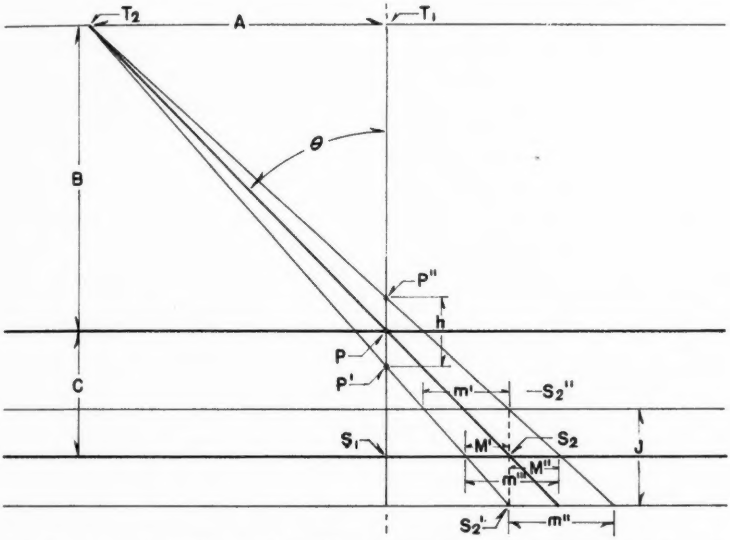

Fig. 8. Effect of thickness of sensitive layer. As the target moves from T_1 to T_2 the shadow of point P in the plane of theoretical focus moves with the film from S_1 to S_2 along the film pivot travel plane which is coincident with the middle of the sensitive layer of thickness J. But points S_2' and S_2'' at the lower and upper boundary of the sensitive layer which received the shadow of P when target was at T_1 now receive instead the shadows of P' and P'', respectively. But during motion the shadow of P', while having no motion relative to the lower surface of the sensitive layer, has moved the distance m' along the upper surface. Similarly, the shadow of P'' remained stationary relative to the upper surface but has moved the distance m'' along the lower surface. Also, the shadow of point P, while remaining stationary at the center of layer has moved the distance M' along the upper surface and M'' along the lower surface, or a distance m''' within the layer. Therefore, no point can be rendered with absolute sharpness. Because the thickness of the sensitive layer is very small in comparison with the distances B and C, the lines T_2S_2' and T_2S_2'' can be considered parallel to one another and to the line T_2S_2. The distances m', m'', and m''' can then be considered equal to one another and from the diagram equal to $J \tan \theta$, and as $\tan \theta = A/B$, $m = JA/B$ where m represents the minimum blurring within the layer, and it follows that this blurring is directly proportional to the amplitude. We also see that the distance h between P' and P'' which represents the minimum thickness of this layer of even blurring is equal to $JB/B + C$. Because C is usually much smaller than B, the minimum possible thickness of this layer is approximately equal to that of the sensitive layer and independent of the amplitude.

size of the target and not entirely independent of the one just described is that caused by the vertical height of the target. A plane in exact focus with respect to the center of the target will not be in exact focus with respect to points above or below that center and, therefore, cannot be rendered without some blurring. This effect is of the same order of magnitude as the blurring due to the increase in projected perpendicular to the axis of amplitude or, in other words, to "thicken" the theoretical plane in focus of "no blurring" to a thin layer of very slight blurring. Rocking the tube so that the central ray is always pointed toward the same point on the film brings this blurring in coincidence with that produced by the projected target area so that it is of little importance in a tomographic system or in a planigraphic system

when the tube is rocked as described. In a planigraphic or laminagraphic system using motion having components along two axes, this effect does not disappear entirely if the tube is rocked along one axis only, and it must be considered as a limitation when large amplitudes are used, though it is negligible for small amplitudes. Rocking the tube along the longest component of motion minimizes this effect to a point at which it becomes a negligible factor in the appearance of the results unless very large amplitudes are used.

(2) *Thickness of Screens and Film.*—Another limiting factor is that due to the thickness of the screens and film.[10]

The shadow of the plane in theoretical focus remains motionless only on the middle plane contained within the thickness of the moving screens and film and has some relative motion at other planes contained therein. The shadows of planes close to the one in theoretical focus have some relative motion with respect to the middle plane of the sensitive layer, while they remain motionless in relation to some other planes therein contained. The result is a "thickening" of the layer of even blurring (Fig. 8). This, under ordinary conditions, approximates the combined thickness of the film and of the effective layers of the screens. The minimum blurring possible with the most perfect mechanical system is that which occurs within the layer of focus as just explained. If we consider a geometrical point of emission and a thickness of sensitive layer of 1 mm., this blurring is approximately 0.3 mm., for an amplitude of 20 cm., a target-film distance of 75 cm., and a pivot height of 10 cm., and 0.9 mm. for an amplitude of 60 cm. The equations obtained from Figure 8 also show that there is a minimum to the thickness of the layer in focus, no matter the value of the permissible blurring. This layer of minimum thickness is approximately equal to the thickness of the sensitive layer and can easily be disregarded when small amplitudes are used because a great depth of focus is then obtained. When large amplitudes which give useful depth of focus of the order of 1 or 2 mm. are used, this effect becomes a recognizable factor because the depth of focus cannot be appreciably smaller than the thickness of the sensitive layers. Under these last conditions, the blurring which occurs within the layer becomes great enough to affect the value of the resulting roentgenograph. Thus, for any given system there is a definite limit to the amplitude which can be used and as this limit is approached we lose, for most practical purposes, more than we gain. This is true for any system of body-section roentgenography and is a real limiting technical factor.

The thickness of sensitive layer of 1 mm. given in the preceding examples is a close approximation of the thickness wherein the physical effects resulting in the blackening of the film take place when duplitized film and screens are used. However, the actual blurring is usually slightly less than the value given because only a small part of the exposure is made when the amplitude is near maximum. It appears from this theoretical analysis, as well as from experimental work, that the maximum useful amplitude is about equal to the distance between the target plane and the pivot plane. This ratio is also very nearly the limit when other factors are considered.

(3) *Elimination of Secondary Radiation.*—The proper elimination of secondary radiation is just as necessary in body-section roentgenography as in conventional roentgenography. In either case, proper coning and the use of a grid diaphragm are necessary when dense, thick anatomical parts are examined.

When only rectilinear motion is employed, proper coning is easily secured with conventional cones if the tube is kept oriented toward the center of the film. If this is not done, a larger cone than would otherwise be necessary must be used to prevent

[10] In this analysis, the normal diffusing effect of intensifying screens is not considered. The sensitive layer is taken as being composed entirely of non-diffusing material. In practical work the diffusing effect of the screens is superimposed on that due to laminagraphic motion.

the shadows of its edge from impinging on the film surface, with consequent increase in the production of secondary radiation. A minimum production of secondary radiation and minimum skin exposure are obtained if rectangular cones or tube diaphragms are used which have openings just big enough to cover the width desired in the direction at right-angles to the motion, and which are long enough so that their shadows do not impinge on the area wanted at the extremes of amplitude. The use of circular diaphragms in such cases is almost worthless.

The use of a grid diaphragm is in no way different from conventional technic if the target motion is rectilinear and parallel to the laminations of the grid (either Potter-Bucky or wafer type), but a loss of efficiency occurs if the motion or any of its components is at right-angles to the laminations of the grid, and the loss becomes relatively greater as the transverse component of motion is increased.

However, transverse components resulting in a decentering of 5 cm. or less at a target-film distance of 75 cm. have little effect on the efficiency of most grid diaphragms. (This includes Potter-Bucky diaphragms of ratios less than five to one and non-oriented wafer grids or one-meter oriented grids used at shorter distances, because they are not very critical to the centering of the tube.) Longer target-film distances permit correspondingly greater decentering before this effect becomes noticeable.

When relatively larger transverse components are used, more of the radiation proceeding directly from the target impinges on the sides of the laminations and becomes ineffective, while proportionately more of the unwanted secondary radiations reach the film. This results in some loss of contrast and fogging as well as a reduced film density near the edges of the film. However, this last is usually no handicap. Most anatomical parts are thicker at the center than at the edges and the lessened density at the edges of the film acts in a compensating manner so that a more evenly exposed roentgenograph often results. In fact, for some anatomical parts, particularly the pelvis, it is rather a help,[11] but the loss of contrast is not desirable. It is a limitation which, though not of paramount importance, must be taken into account when a relatively large component of amplitude transverse to the grid structure is used to cover a large film area.

Other causes render the ordinary Potter-Bucky diaphragm unsatisfactory for certain motions. When the motion is curvilinear (circular, spiral, sine, etc.) the component of motion transverse to the grid is not of uniform translation, and this variation in speed gives rise to grid marks for the following reasons.

When the target and film move tangentially to the grid laminations, the Potter-Bucky acts as it would for rectilinear motion parallel to its structure and it performs its function normally: the shadow of the moving grid structure travels on the film at its proper rate and is adequately blurred. However, when the target and film do not move tangentially to the laminations, the travel of the grid shadow on the film is no longer uniform and grid marks ensue. (There may even be times when the grid shadow remains momentarily stationary on the film.) There appears to be no remedy for this when an ordinary Potter-Bucky is used. If the Potter-Bucky is made to move with the film, the inertia of the grid renders its travel non-uniform with respect to the film and, even if this inertia effect were not present, the grid shadow would still have a non-uniform speed of travel on the film because the grid is not in juxtaposition with the film surface. The use of some type of wafer grid is, therefore, essential with curvilinear target motions. If rectilinear motion which has a component transverse to the Potter-Bucky grid laminations (either perpendicular or ob-

[11] The author has used for many years a technic for conventional roentgenography of the pelvis in which the target-film distance is increased beyond the one recommended for his Potter-Bucky diaphragm (35 instead of 30 inches) to take advantage of just this effect. The crest of the ilium is much less blocked out when proper density of the sacral region is obtained than with the use of the recommended distance.

lique to them) is used, it must be of very uniform speed or grid marks may result. Also, the direction of the motion should be such as to increase the speed of the grid shadow across the film (opposite to the grid motion), otherwise it might move very slowly or remain stationary on the film with subsequent development of grid marks.

The use of wafer grids obviates these difficulties. On account of the fine spacing of the grid structure, objectionable grid marks are eliminated, no matter what motion is used. The grid structure is effectively blurred and usually indistinguishable, even on close inspection, if the grid is mounted in such a way that it moves with the film during the component of motion parallel to its laminations while the film moves under the grid during the transverse component.

The wafer grid may even be placed directly over the cassette and made to move with it. The distance between the grid structure and the film allows the shadow of the grid to move on the film and this often results in satisfactory blurring unless the layer in focus is close to the table top and small amplitude used.

Coning is also difficult when the tube moves in a curvilinear path and is not kept oriented at all times toward the center of the film. Rectangular cones or diaphragms are almost useless because their openings, if large enough to secure proper coverage of the film at the extreme of amplitude, will be so large that they will no longer appreciably reduce the irradiated body area.

Variable slot-limiting diaphragms prove very satisfactory when mounted under the tube in such a way that one limits the beam transversally and the other longitudinally, and both keep the effective beam centered on the area wanted and on the film. When such diaphragms are used, the irradiated area and consequently the production of secondary radiations may be kept at a minimum.

(4) *Target-film Distance during Motion.*—This effect is really of little importance but should be mentioned in a complete analysis. In a planigraphic system the target-film distance along the central ray varies during motion, while the perpendicular target-film distance remains constant; and in a tomographic system the target-film distance along the central ray remains constant while the perpendicular target-film distance varies. In both systems the length of path of radiation through the body usually varies during motion and is normally greater at the extremes of amplitude than at the center. This last is most evident with motions of large amplitude in which its effect is to increase the amount of radiation necessary for a given film density. (For example, with an object 25 cm. thick throughout, the longest path through the body along the central ray is 27.5 cm. for T.F.D. 75 cm., pivot 10 cm., amplitude 60 cm. (30 cm. from center), and the longest path to corner of a 14 × 17 in. film at the limits of amplitude is 32 cm., instead of 26 cm., when the tube is centered over the film.)

Due to the fact that a tomographic system is the homologue of a planigraphic system when the perpendicular target-film distances are equal at the *limits of amplitude,* the tomographic system is the less efficient of the two, because the target-film distance is greater at the center of travel and, therefore, necessitates more radiation for the same film density. (For the example above given the target-film distance at center is 82.5 cm.)

Economical Limitations.—These limitations are, of course, only relative. They include cost of special equipment, cost of extra films necessary, and cost of space or other extra facilities necessary in certain cases. They can perhaps be analyzed and discussed to better advantage later.

VARIOUS MOTIONS

An analysis of the advantages and disadvantages of certain motions must be considered, and the motions useful for laminagraphy may be divided as follows: (1) Rectilinear; (2) Circular; (3) Spiral; (4) Sine (sinusoidal) or approximately sine.

Other motions have been used, such as crosses, repeated rectilinear lines parallel to one another, combination of circular or spiral motion with rectilinear motion, etc. They will not be discussed here because they have not proved more useful than those above and are more complicated.

(1) *Rectilinear Motion.*—The blurring caused by this motion is only a one-way blurring.[12] The appearance of the resulting roentgenograph depends on the orientation of the object with regard to the direction of motion. Residual shadows of dense objects result in streaks across the plane in focus and if these objects are elongated in the direction of motion, their residual shadows, though blurred in detail, are still quite dense and troublesome. To offset this effect, comparatively large amplitudes must be used with a resulting very small depth of focus. The appearance of the resulting roentgenograph is apt to be misleading. The residual images of the objects not in the layer in focus are badly distorted and *the layer in focus itself appears thicker and sharper than it really is. The apparent thickness and sharpness are due to the superimposition of sharp residual shadows of structures oriented in the direction of motion and close to the plane in focus.* For instance, if a pulmonary cavity, the walls of which we will imagine to be spherical and uniform in thickness, were roentgenographed so that the plane in focus would be across this cavity, the walls would appear thicker where the motion is in a direction tangential to them than at the place where they are oriented at right-angles to the direction of motion. Also, if a blood vessel or bronchus is oriented in the direction of motion, but at an angle to the film surface, it will be recorded sharply for a longer segment than a similar structure oriented at right-angles to the motion, and erroneous conclusions as to their relation to one another will result unless previous knowledge precludes this. At times, elongated structures with little internal detail (blood vessels, malignant infiltration, etc.) may be actually located completely outside of the plane in focus, but their outlines, if oriented in the direction of motion, may be still so sharp that they will appear to be in the plane of focus. The body-section roentgenographs resulting from the use of *rectilinear motion may be very misleading unless one already knows what is there.* (I do not mean to imply that the use of rectilinear motion is valueless. I merely wish to point out its very definite limitations in order that the user may guard against drawing false conclusions.)

The advantages of rectilinear motion are mostly of an economic nature. The apparatus for its use should be less expensive than those using compound motion because they need not be as complicated. Standard roentgenographic tables may be easily adapted (Alexander, 3; Taylor, 13; Twining, 14; Schwarzschild, 12, and others). A standard Potter-Bucky diaphragm may be used if the motion is parallel to the grid structure. (If at right-angles it loses much efficiency, though this makes it easier to position the patient, particularly for chest work, Bush, 6.) Proper coning is easily accomplished if the tube is rocked so that it always points toward the center of the film. The resulting roentgenographs are usually more brilliant than with other motions because the Potter-Bucky diaphragm is used at full efficiency.

With one exception, these remarks also apply to a tomographic system: its economical limitations are greater because a standard roentgenographic table is not easily adapted to it. A special apparatus is usually necessary and if such apparatus is constructed so that the film surface is as near as possible to the plane in focus at all times (in order to minimize the unsharpness due to the size of the target), mechanism more complicated than that for a planigraphic system must be used to change the height of the pivot point with regard to the

[12] In this analysis we will include tomographic motion because the projected target paths at various points on the film are straight or nearly straight lines (straight lines for points in the plane of the segment of arc described by the target, and segments of ellipses for other points, but these elliptical segments are so nearly straight under ordinary technics that we may consider them so).

film surface. If the pendulum action of such a system alone is used as the motive power, the exposure time is inelastic and the adaptation to various technics difficult. If other motive power is used, mechanical complications and their incident cost are again increased. The advantages of the simple lever arm of the tomographic system are thus entirely offset by the complicated mechanical arrangements necessary to make such a system satisfactory for practical working conditions. Also, such equipment is not very suitable for conventional roentgenography unless more mechanism is added. If this is not done, the space necessary for additional equipment will usually be another economical limiting factor. It is thus evident that from an economic standpoint alone a rectilinear planigraphic system is much superior to a tomographic system, while its results (for equal technical factors on carefully built equipment) have the same diagnostic or informative value.

(2) *Circular Motion.*—Because circular motion has equal amplitude for all axes, the appearance of the roentgenographs resulting from its use does not depend on the orientation of the object roentgenographed. Similar structures in the layer in focus will be similarly represented, regardless of their orientation, and the residual shadows of objects outside the layer in focus will not be distorted. However, these residual shadows may be very troublesome under certain circumstances.

The path on the film of the shadows of objects not in the plane in focus will be circular and their residual shadows annular, and the crossing of these annular shadows will give rise to noticeable areas of decreased density if the objects causing them are relatively dense. Also, when the target moves tangentially, or nearly so, to elongated objects, their shadows will be displaced mostly lengthwise and the film blackening produced at that time will be smaller than that produced by the same objects while the target is moving at right-angles or nearly right-angles to them. As the target motion is tangent to elongated objects at two places in its travel, the resulting residual shadows will have an appearance suggesting a double outline of the object or of its edges. For objects not very dense or far from the layer in focus, this double outline will hardly be visible on account of the relative spreading of the shadow on the film, but for dense elongated structures relatively near this layer (for instance, ribs) this effect is strong enough to interfere seriously with the visualization of the layer wanted or to cause residual shadows to appear to be the image of structures within that layer.[13] These interfering shadows, however, do not occur so often and are much less dense than those caused by rectilinear motion of the same amplitude and are more easily recognizable as artefacts.

The use of circular motion requires more complex, and consequently more costly, mechanical systems than those required for planigraphic rectilinear motion, but such systems can be made easily adaptable for conventional roentgenography. Circular motion is not suited to the use of a Potter-Bucky diaphragm, but requires the use of a wafer type grid for the proper elimination of secondary radiation. Circular motion of relatively large amplitude entails a corresponding loss of efficiency in the function of this grid. Proper coning is more difficult with circular than with rectilinear motion. Circular motion is also less adaptable to the use of relatively large amplitudes. However, its amplitude is readily controlled so that small amplitude and consequently great depth of focus are available for scouting films or for the visualization of objects distant from interfering structures. Circular motion also permits great elasticity of technics. The minimum permissible exposure is that required for one complete turn (in the order of one second with present-day equipment) and there is no limit to the

[13] The appearance of the resulting roentgenograph is quite similar to the appearance of a microscopic dark field when focused through a thick layer. There the residual images of brightly illuminated points out of the focal plane are also annular, and the identification of combinations of these annular images as artefacts is difficult at times.

length of exposure possible above that. The system is merely kept turning until the desired exposure time has elapsed.

(3) *Spiral Motion.*—With one very important exception the use of spiral motion results in roentgenographs similar in appearance to those obtained with circular motion of the same amplitude.

Tangential residual shadows of elongated objects are replaced by a multiplicity of outlines which are usually so faint that they are not recognizable as sharp outlines. This is due to the fact that the shadows produced on the film by objects outside the layer in focus do not fall in the same place on consecutive turns of the system. In other words, there is a transverse spreading of these shadows which results in a much more even blurring.

Because the images of objects not in the plane of focus are evenly blurred and undistorted, the formation of artefacts is avoided and, as I have stated in a previous paper (9), "the hazy background produced is not at all disturbing; in fact, helps the roentgenologist because he obtains a very distinct impression of the relation of the layer sharply visualized to the body structures in which it lies."

This is particularly true with the use of a parabolic spiral of from four to six turns such as I have described in the paper mentioned. If an Archimedean spiral is used instead, much more of the exposure time will be used while the target is near the center and a reinforcement of the residual shadows produced at that time will occur, with the consequent possibility of the production of artefacts, as well as a loss of visibility of the layer in focus where the residual shadows of dense objects are superimposed on it.

Spiral motion, similar to circular motion, is not very suitable for relatively large amplitudes on account of the cumbersome equipment which it would necessitate. The addition of spiral motion to a system suitable for circular motion is easily accomplished by the inclusion of a cam or templet in the driving system. The other mechanical requirements and technical and economical limitations are the same for both motions, except that the elasticity of technic is not as great when spiral motion is used because the exposure is more limited. However, exposures of suitable length for any ordinary technic may be made readily available by varying the speed of rotation of the system.

The minimum exposure practical with spiral motion is from three to five seconds. Faster exposures are possible, but at a much greater equipment cost.

(4) *Sine Motion.*—Under this heading are considered motions with true sine or approximate sine characteristics. Sine motions are obtained by compounding a harmonic or nearly harmonic motion with a rectilinear motion. It provides blurring of unwanted shadows in two directions, and the appearance of the resulting roentgenograph depends on three factors: first, the shape of the actual path of the target; second, the relative value of the rectilinear components along the axis of greatest amplitude to the one at right-angles to it, and third, the orientation of the object with respect to these components.

The shape of the actual path of the target depends on the length of the rectilinear motion, the amplitude of the harmonic motion, and the number of times that motion is repeated during the rectilinear travel. If the harmonic motion occurs more than once (Fig. 7, Diagrams 9 and 11), the components at right-angles to each other can be considered, for all practical purposes, equal to the length of the rectilinear motion and the amplitude of the harmonic motion, respectively. If the harmonic component is not repeated, the resulting motion is the approximate equivalent of a diagonal rectilinear motion and the smaller the portion of the harmonic component the nearer the resulting motion approaches a rectilinear path, and the following analysis does not apply. (In one commercial model, the target path is similar to a very elongated half-sine wave (Fig. 7, Diagrams 10-*A* and 10-*B*). The ratio of the component along the axis of greatest amplitude to that at right-angles to it is

very small, and though there is more efficient blurring than for rectilinear motion of similar amplitude, it is not efficient enough to remove streaking.)

If, instead of rectilinear motion, a motion is used in which the target moves transversally three or more times during its longitudinal displacement, the small depth of focus due to the longitudinal amplitude is retained, with its consequent effect of great spreading of dense shadows, while the transverse component adds transversal blurring. The repetition of this transverse component allows the residual tangential shadows of elongated structures to fall successively at different places, thus greatly reducing their densities. The appearance of the resulting roentgenograph is midway between that obtained by rectilinear motion and that obtained by spiral motion. There is no streaking, but some distortion of the residual images of the planes not in focus is present and the elimination of sharp residual outlines is not complete, so that artefacts can be produced.

The advantage of repeated sine motion is that it permits better visualization of structures otherwise obscured by dense elongated objects than would be possible with rectilinear motion of similar amplitude and orientation, or with circular or spiral motion of smaller amplitude. Its use requires mechanical systems more complicated than for any other motion described. The necessary mechanism is more easily added on apparatus suitable for circular or spiral motion than on apparatus suitable to rectilinear motion only. In fact, an apparatus suitable for the use of circular and spiral motion is capable of performing sine and rectilinear motion also with little or no change.

DISCUSSION

As the art of roentgenography has evolved, an increasing number of technics have been developed. The need for these special technics became evident soon after the first medical roentgenographs were made and the main reason for their development was primarily a striving for "more information." As roentgenographic technic improved and the art of interpretation developed, it soon became evident that "more information" consisted of two things: first, more definite positive findings, and second, less false findings. That is, that the shadows viewed by the diagnostician should present as clear and as truthful a representation as possible of the condition of the anatomical part under consideration.

We must pause to define the words "clear" and "truthful," or what will follow may become meaningless. These two words are often used as approximate synonyms. It would be fatal to this discussion to consider them as such. By "clear" we mean easily visible; that is, sharp, free from fog, of adequate contrast, and unobstructed. By "truthful" we mean "accurately represented"; that is, undistorted and free from artefacts. And here we must introduce another definition: that for "undistorted." Let it be emphasized that a uniform difference in size only is *not* distortion, but that a non-uniform difference in size is. That is, the reproduction of a plane in a different size from the original is not distortion if the same proportional difference applies to all parts of the plane; it is only magnification or reduction. For instance, a photomicrograph is not distorted. If the difference in size is greater in one axis than in another, or different for various parts of the plane, the reproduction is distorted. Similarly, if a number of planes are considered, as the planes which go to make a solid object, and these various planes are reproduced at different magnifications on one film, the reproduction of the *object* is distorted, though the reproduction of any particular plane may not be.

Notwithstanding all the recent advances of roentgenography, a clear and truthful roentgenograph is the exception rather than the rule if the meanings given above are kept in mind. Modern technics produce sharp roentgenographs free from fog and of adequate contrast, yet, on account of superimposed shadows, many of these are far

from clear. The superimposition of shadows may be minimized by means of oblique projections, but, by so doing, distortion is often introduced and false shadows are produced which render the roentgenograph far from truthful. For any given roentgenographic problem *the best possible compromise will give the best possible roentgenograph*.

The trained roentgenologist can usually detect false shadows and get at the truth beneath—usually, but not always. At times these false shadows give such a close imitation of what might be true that they are considered true, and false deductions made from them; at other times, regardless of the technic used, the best obtainable roentgenographs cannot give a representation clear and truthful enough to permit definite deductions to be made. Unfortunately, even when this condition exists, "positive deductions" are too often made and what is not there declared to be there or what is there declared not to be there. A satisfactory roentgenographic study, therefore, should give the maximum positive information consistent with the absence of false information.

It will be noticed immediately that this definition implies a receiver for the information. In other words, a satisfactory roentgenograph depends on who is looking at it and what he is looking for. A well trained roentgenologist will be able better to notice positive findings and discount possibly false shadows than one not so trained, so that a roentgenograph barely satisfactory for the trained man is entirely unsatisfactory for the untrained. Yet it is the less trained man who most often interprets unsatisfactory roentgenographs.

It can then hardly be gainsaid that it is better if the roentgenograph is not clear than if it is not truthful. It is better that no deduction be possible, due to lack of clarity, than that an erroneous statement be made because the roentgenograph is not a true representation of the anatomical part under observation. Our definition of a satisfactory roentgenograph should therefore emphasize the absence of "false information."

The production of satisfactory roentgenographs, then, resolves itself into choosing the technic which will give a view of the anatomical region under study clear enough to furnish the information desired and free of misleading shadows. This choosing is a matter of making the proper compromises among many different factors: short focal distances *versus* detail; oblique views *versus* distortion; focal size *versus* length of exposures; speed of screen *versus* definition; contrast *versus* kilovoltage, etc. The many standard technics of to-day are the results of many years of experience and produce satisfactory roentgenographs in most instances. For those instances in which standard technics are inadequate, body-section roentgenography now offers a way to produce satisfactory roentgenographs. But body-section roentgenography also introduces new factors which must be taken into consideration before the proper compromise necessary for satisfactory roentgenographic studies can be made.

We have just seen what these factors are and how they influence one another. Some are inherent in laminagraphic technics, others are present in standard technics but must be revalued in the light of their effect on laminagraphic results.

Considering the preceding analysis, we can state:

(1) The effect of laminagraphic motion on the image of objects not in the layer visualized is twofold: first, it spreads the shadows of large dense objects over larger areas of film than standard technics and thus reduces their densities. The larger the amplitude of motion used, the better this effect. Second, it blurs the images of fine complex structures and thus reduces their visibility. The more symmetrical the area bounded by the motion and the more the linear path of the target tends to evenly fill this area, the better this effect. Both effects permit a clearer view of the object wanted.

(2) The larger the amplitude used, the thinner the layer in focus and the greater

its unsharpness. The first is inherent in any laminagraphic motion, no matter how perfect the system used. The second is due mostly to the material thickness of the sensitive layer (film and screens) as well as to the material size of the target.

(3) The practical motions are of four general types: rectilinear, circular, spiral, and sine. No one is best for all purposes.

(4) The production of artefacts is smallest with spiral motion and greatest with rectilinear motion, due to the even and undistorted blurring produced by the former and to the uneven and distorted blurring of the latter.

(5) Rectilinear motion along a plane is more practical than motion along segments of an arc. The mechanical advantages of the simple lever arm of the tomograph are more than offset by the complex mechanism necessary for its practical use if elasticity of technic and adaptability for conventional work are considered.

(6) The elimination of secondary radiation is more efficiently accomplished with rectilinear motion than with any other motion because there is no loss in the efficiency of a grid diaphragm. This is true only if the motion is parallel to the grid structure.

(7) For a given amplitude the unsharpness in the layer in focus is smaller with rectilinear motion than with any other motion. This is due to mechanical limitations as well as to the height of the place of emission, but added unsharpness is usually very slight.

(8) No matter what motion is used, the unsharpness is greater than with comparable standard technics. This is due to the material thickness of the sensitive layer and the material size of the target. The smaller the target and the thinner the sensitive layer, the smaller this effect.

(9) Exposures much under one second are not permitted by present-day equipments. Many attachments cannot use less than two or three seconds—specially built equipment usually one second, occasionally one-half second.

(10) It is usually necessary to take more than one roentgenograph, due to the limited thickness of the layer adequately recorded.

Of all these factors, the most important one is that "the larger the amplitude, the thinner the layer in focus" because it is inherent in laminagraphic technic. It is true with a theoretically perfect system, and the most important compromise to be made is based on this fact.

If the object to be visualized is hidden by large dense objects close to it, a large amplitude must be used with its consequent representation of a very limited layer of the object, and if a view of more than this limited layer is necessary, repeated exposures at various levels must be made. It is doubtful if, as suggested by Chaoul (7), taking various layers on one film by moving the pivot point during exposure is a satisfactory compromise, because the sharp image of any layer obtained while the pivot plane is in one position is only a fraction of the density of the final image and is obscured by its own blurred image while the pivot plane is at another position.

However, due to the fact that for any given maximum amplitude the shadows of dense objects not at the plane in focus cover a greater area with circular, spiral, or sine motion than with rectilinear motion, a smaller amplitude of these motions may be used for similar spreading and consequently a greater depth of focus is obtained for equal visibility. If the object to be better visualized is not hidden by large dense structures close to it, a reduction in the amplitude will bring more of the object into view at one time, so that a full study of this object will require a smaller number of roentgenographs. The prime compromise to be made in laminagraphic technic, therefore, is that of amplitude *versus* thickness of the layer in focus, and the best amplitude to use is that which will give the information wanted while using the smallest number of films.

Because no clear-cut difference exists between the plane in focus and the adjacent planes, the section clearly visualized is not a true plane but a layer of definite thickness. This thickness may be consid-

ered as the thickness of the section which is recorded in such a way that adequate information can be derived from it. It may be called the "depth of focus" and is the thickness of the layer which is represented on the film within a given "permissible unsharpness." This permissible unsharpness depends mostly on the information sought. Its minimum value is, of course, that which will make no *visible* difference on the roentgenograph and is approximately equal to the resolving power of the human eye or to the resolving power of the sensitive emulsion and intensifying screens used, whichever may be the larger. Under normal conditions, it is of the order of 0.3 mm. But for many diagnostic problems a much greater unsharpness is permissible without affecting the ability of the roentgenograph to give the information sought. The smaller the value of the unsharpness, the better the roentgenograph, *other things being equal*. But sharpness is not the only criterion of a satisfactory roentgenograph, and under practical conditions a degree of sharpness beyond that which gives the information desired accomplishes no useful purpose.

In determining the presence or absence of many lesions (cavities, tumors, abscesses, etc.) and their extent, an unsharpness of one millimeter or more in no way affects the information derived, and many satisfactory conventional roentgenographs show an unsharpness of the anatomical region under study greater than this value.

The term "permissible unsharpness" is, therefore, used in this discussion with the meaning of "maximum unsharpness consistent with visualization of the part under study adequate to the information sought."

The next compromise is that of best theoretical motion against best practical motion, and we plunge into a subject which may remain controversial until more extensive practical use of body-section roentgenography has been made. The preceding theoretical analysis has shown that parabolic spiral motion gives better results than any other motion of *similar amplitude and length of exposure*.

Practically, spiral motion is not easily used for relatively large or relatively small amplitudes; it requires exposures of longer time than rectilinear or circular motion; it does not give as fine detail and does not permit as efficient elimination of secondary radiation as rectilinear motion, and apparatuses for its use are more costly than those for rectilinear motion.

The factor of cost is one which, for this as for any other roentgenographic method or apparatus, must be decided by individual circumstances: it will not be considered further. Suffice to say that the use of parabolic spiral motion for body laminagraphy has up to the present justified its cost in the opinion of most of those who have used it clinically in comparison with other motions.

The fact that spiral motion in its practical application does not give as fine detail as rectilinear motion might appear to be an important limiting factor. In reality, it is not so. The added unsharpness due to the height of the focal spot is so small at the value of amplitude to which the spiral is limited as to be practically negligible. For average technic it is smaller than the unsharpness caused by the thickness of the sensitive layer. The unsharpness caused by lost motion in properly designed apparatus is usually a negligible portion of the "permissible unsharpness," and the loss of efficiency of the grid diaphragm is also of little import in most cases. However, when optimum sharpness and contrast are demanded, these factors must be kept in mind if the best compromise is to be reached.

Also, the fact that exposures under three seconds are not practical with spiral motion is not as much of a limiting factor as the mere statement implies. Exposures of over three seconds are usually no handicap in standard roentgenography except in chest work in which it is desirable to eliminate the unsharpness produced by the motion of tissues due to pulsation of the heart. But unsharpness due to this cause is not eliminated by exposures of one second and it is no greater if exposures of from three or

five seconds are used. In fact, it is no greater after one full pulse has been completed than after many, and the exposure necessary for the fastest rectilinear motion available at present cannot be completed in much less than one pulse beat. The occasions when amplitudes larger or smaller than those permitted by spiral motion are desirable also are comparatively few for body-section roentgenography in general; therefore, we find that spiral motion is best suited for the majority of cases in which sectional roentgenographs are desirable.

When small amplitudes in the order of 12 cm. or less are required in order to obtain great depth of focus, spiral motion cannot be used and circular is better than rectilinear motion because it produces a greater blurring of shadows above and below the layers in focus for any given depth of focus.

When exposure times under three seconds are required, spiral motion cannot be used and circular motion is usually a better compromise than rectilinear motion, unless a large amplitude is also desired, for the same reasons and with the same limitations that apply to spiral motion.

When large amplitudes are required, neither spiral nor circular motion is practical. If the length of exposure is relatively unimportant, sine motion is usually a better compromise than rectilinear motion, because it spreads unwanted shadows over a greater area for the same amplitude, subject to its limitation of slightly greater unsharpness or loss of efficiency in elimination of secondary radiations.

If large amplitudes are required within a minimum length of exposure, rectilinear motion, with its attendant distortion of residual shadows and consequent artefacts, is at present the only practical motion.

So we find, unfortunately, that no single type of movement is best for all roentgenographic problems. Rectilinear motion is the simplest but may give fallacious results; sine motion is useful for a few body parts; spiral motion is best for the majority of cases, and the value of circular motion lies mostly in elasticity of exposure though it is also valuable when great depth of focus is desired.

Evaluation of General Method.—Body-section roentgenography cannot be evaluated as against conventional roentgenography; it can be evaluated only as an *addition* to it. Probably few, if any, standard roentgenographic procedures will be replaced by body-section roentgenography. As pointed out by Moore and others, standard roentgenographic methods should precede its use.

Additional information about anatomical regions or lesions may be obtained by body-section roentgenography which is unobtainable by other methods. This is the main reason for its existence. Its general advantages and limitations are those set forth for each particular motion: that is, visualization of structures not revealed by other methods, or more accurate visualization or localization of structures capable of being revealed by other methods, and these advantages are obtained at the expense of a reduction in the sharpness and general contrast obtainable by standard methods, but not at the expense of local contrast. Because of the reduced thickness of the region visualized on one film, much smaller differences in the density of adjacent parts will produce visible differences in density on the film. Hence the added ability of body-section roentgenography to render visible structures which, on account of small differences in density, cannot be revealed by the best conventional technics.

It has revealed lung abscesses through extremely dense lung-fields and permitted the determination of their exact location; it has revealed small cavities or infiltrative areas in lung-fields of normal or nearly normal densities; it has revealed malignant growths through atelectatic regions and definitely shown the bronchial stenosis which caused the atelectasis. It has revealed the cause of previously undetermined abdominal calcification as being due to abdominal aneurysm and has shown the aneurysm in its entirety. It has revealed

small lesions in the center of vertebral bodies; it has revealed tumors of the cord. It has revealed fractures of the auditory canal. It has revealed and accurately localized foreign bodies. It has accurately shown the location and amount of dislocation in upper cervical vertebræ. It has revealed all these things and a great many more after thorough standard roentgenographic procedures in some of the best laboratories had failed. In many cases the information thus gained has been greatest and at times possible only with parabolic spiral motion.

On these results and not on the sharpness or contrast of a roentgenograph, or on its cost, should the value of body-section roentgenography be decided. I believe that body-section roentgenography and especially laminagraphy with the use of parabolic spiral motion, has already demonstrated its value.

SUMMARY

The motions usable for body-section roentgenography are discussed.

The importance of the proper evaluation of sharpness and depth of focus are stressed.

Rectilinear, sine, circular, and spiral movements are analyzed and their values and drawbacks described.

It is shown that, unfortunately, no single type of movement is best for all roentgenographic problems; that rectilinear motion is simplest but may give fallacious results; that sine motion is useful for a few body parts; that spiral motion is best for the majority of cases, and that the value of circular motion lies mostly in elasticity of exposure though it is also valuable when great depths of focus are desired.

An attempt is made to evaluate body-section roentgenography on the premise that "a satisfactory roentgenographic study should give the maximum positive information consistent with the absence of false information and that this can be achieved only by making the proper compromises."

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SECTIONAL ROENTGENOGRAPHY OF THE LARYNX[1]

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IT was not until November, 1936, when Andrews (1) published a thesis on the history and development of planigraphy, that any real interest in the subject was shown by the roentgenologists of this country. The geometrical and experimental proof of the practicability of the planigraphic principles (2, 3, 4, 5) has been demonstrated. Among the men who independently worked out methods of body-section roentgenography and developed apparatus for its execution are Vallebona (6), Ziedses des Plantes (7), and Kieffer (3).

The apparatus used in this demonstration has a fixed tube-plate distance of five plus feet. The vertical excursion of the tube measures 31 in. with a side shift of the tube of 4 in. The motion closely simulates that of a railroad car when it is switched from one to the adjoining parallel track. The time of exposure is just under one second. This fixation of motion, time, and distance has many disadvantages over the more labial type of apparatus. On the other hand, the technic is simplified and to a certain extent the type of distortion of objects above and below the focal plane is constant, and can be readily differentiated. A study of this distortion was demonstrated by Ziedses des Plantes with a graded cylinder (8). It can also be shown by a ladder, each step 1 cm. high, with lead letters marking the height of each level above the table. Figure 1-*A* demonstrates such a ladder and Figure 1-*B* planigraphic sections of this ladder at 2, 5, 10, and 13 cm. levels. A study of these sections gives a graphic representation of the thickness of the focal plane, namely, from one to one and one-half cm. It also illustrates the oblique character of the blurring and the amount of distortion of

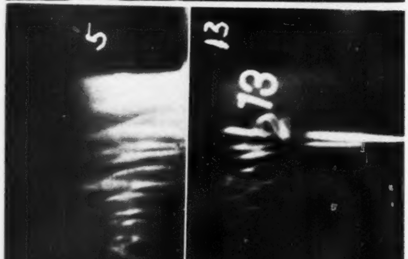

Fig. 1-*A* (*above*). Fig. 1-*B* (*below*)

[1] Presented before the Twenty-fourth Annual Meeting of the Radiological Society of North America, at Pittsburgh, Nov. 28–Dec. 2, 1938.

objects immediately above and below the focal plane.

There has been some question among roentgenologists as to the relative value of this type of examination. The disadvantages of sectional roentgenography should include:

(A) *Apparatus.*—Apparatus is expensive, except for certain homemade instruments, the accuracy of which must vary. It is complicated by moving parts and any inaccuracy in the relationship of this motion will distort the result. Motion of the plate holder prevents it from coming in close contact with the part to be studied.

(B) *Blurring.*—Parts close to the focal plane are of necessity incompletely blurred, which tends to make less clear the detail in the focal plane. In other words, there is always a slight residual blurring on each film.

(C) *Examination Incomplete in Itself.*—The planigraphic examination in itself is incomplete (11) as compared with ordinary roentgenography and therefore must be supported by an additional examination consisting of routine views. This consumes time, adds to the expense, and may be tiring to a debilitated patient.

(D) *Amount of Radiation Received.*—A grid is necessary to cut down scattering and aid contrast. Its addition increases materially the total amount of radiation received in taking films of any one part, *i.e.*, from one to three. Furthermore, Grossmann (12) states that with circular movement not less than from three to five seconds of exposure time are necessary and with the spiral movement this time is increased to from 10 to 15 seconds. Kieffer (28) states that under average conditions the circular and spiral motions require approximately one and one-fifth the exposure necessary to take a given part, other factors remaining the same. Thus there are certain limitations to this technic, both from a time factor and from the total amount of radiation necessary in making multiple exposures.

(E) *Interpretation.*—Technical procedures do not in themselves lead to a diagnosis. The planigraphic films still need interpretation.

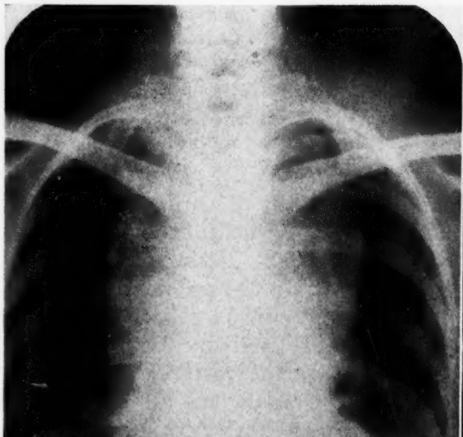

Fig. 2-*A*. X-ray of chest showing thyroid tumor.

Fig. 2-*B*. Planigraph showing intrinsic larynx.

The advantages of sectional roentgenography should include:

(A) *Localization.*—Accurate localization of a given lesion, which includes foreign body, pleural adhesions, etc.

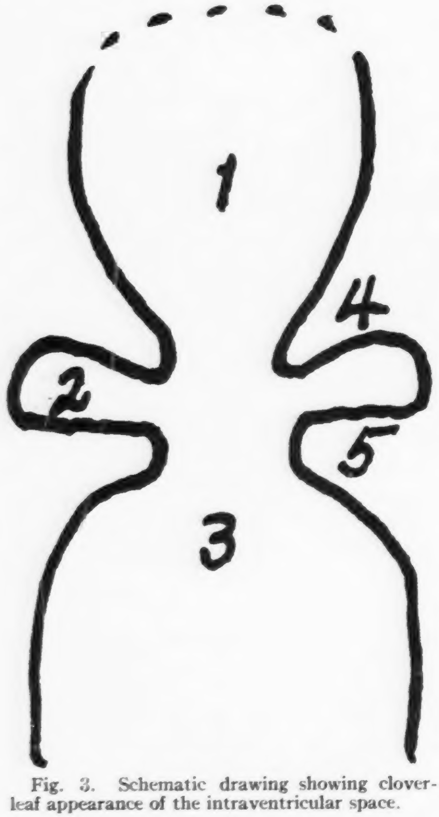

Fig. 3. Schematic drawing showing cloverleaf appearance of the intraventricular space.

1. Laryngeal vestibule. 2. Laryngeal ventricle. 3. Subglottic space. 4. Ventricular fold—false cord. 5. Vocal fold—true cord.

(B) *Differentiation.*—More accurate differentiation of certain pathology, through the obliteration of superimposed shadows, as in the demonstration of cavity within an area of consolidation.

(C) *Anatomical Parts.*—More accurate anatomical study, as in the demonstration of pulmonary artery, pulmonary vein, and the visualization of the relationship to their bronchus (9, 10).

(D) *Visualization of Air Passages.*—With the further demonstration of the primary and secondary bronchi, it would seem possible to visualize a non-opaque foreign body or a defect within the bronchial wall.

Publications and my own personal experience show that the results obtained by stratigraphy or planigraphy can in no way be compared or duplicated by the ordinary roentgenographic methods, even with the addition of the Potter-Bucky diaphragm. Its application to the present time has been limited mostly to the chest and skull. The study of the spine, bones, and joints has opened up new fields for investigation.

In making planigraphic studies of an individual suffering from a large anterior superior mediastinal tumor, the attention of the author was drawn to the clear visualization of the vocal cords. It was felt that if these could be seen so clearly through a tumor, the larynx could be further studied with this technic. (Figs. 2-*A* and 2-*B*.)

The larynx can be visualized only by mirror examination or direct laryngoscopy. Due to the superimposition of the cervical spine in the usual anteroposterior x-ray films, only lateral studies of the soft tissues of the neck have proven of diagnostic value. The larynx has been visualized by the instillation of opaque oil (Bouchet and Huet, 13; Lemaître, 14; Zuppinger, 15; Waldapfel, 16, and others). Special films have been devised which are placed within the esophagus and this method has been reported by Ledoux-Lebard, Garcia-Calderon and Djian (19) and Ledoux-Lebard and Djian (20). This latter procedure is naturally frought with a great deal of difficulty.

Postero-anterior sectional views were first demonstrated by Gunsett (21) in 1937, and further articles have been reported by Canuyt and Gunsett (22, 23), Gunsett and Schneider (24), J. Didiee (25), and K. Greineder (26).

PHYSIOLOGY

The fact that the larynx is surrounded by cartilage and muscle tends to lend a certain type of mobility to the whole larynx, which is best illustrated by deglu-

tition, in which the larynx is brought up in contact with its lid, the epiglottis. There is also some upward motion of the larynx in phonation, though not as pronounced as in swallowing. The vocal cords make a through the larynx in its middle to anterior third, Didiee has aptly likened the shadow of the air passage between the cords as taking the shape of a clover leaf (Fig. 3). The upper leaf corresponds to the air vesti-

Fig. 4-*A*. Specimen of tongue and larynx.
Fig. 4-*B*. Dissection of plane through the larynx.

V-like aperture, as seen in relaxation, in the usual mirror examination. The posterior edges of the cords tend to approximate themselves in phonation of certain vowels as "e," "o," etc.

PLANIGRAPHIC APPEARANCE

Anterior Third.—In describing the appearance of the planigraphic section bule, while the lateral leaves which are proportionately smaller, make the shadow of the two interventricular fossæ. Below, the stem enlarges to form the subglottic portion of the trachea.

In normal relaxation as in expiration, the width of the air space will vary slightly with the individual and the depth of the planigraphic section, from one-half to one

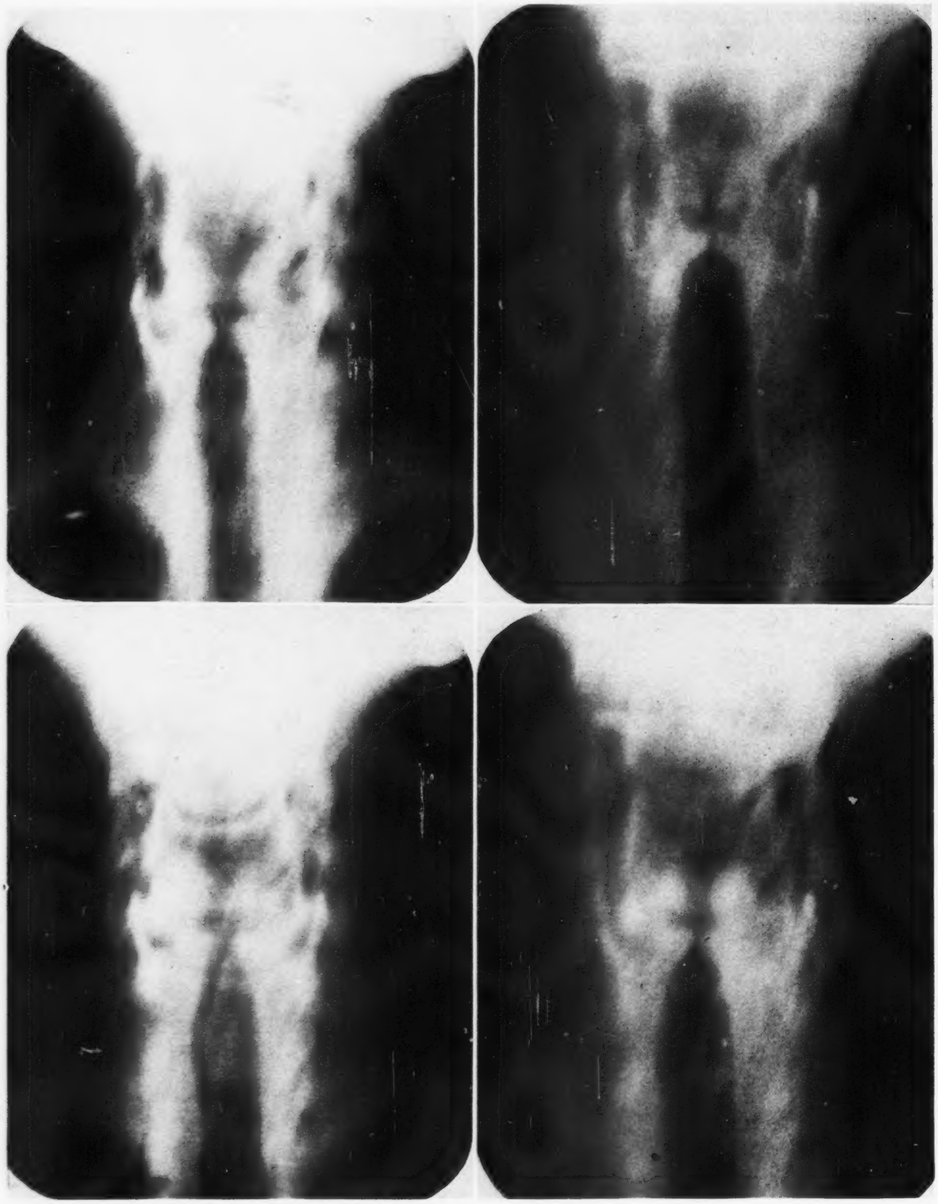

Fig. 5-*A* (*upper left*). Planigraph of larynx at 5 cm. level (relaxation).
Fig. 5-*B* (*upper right*). Planigraph of normal larynx at 5 cm. level phonating "e."
Fig. 5-*C* (*lower left*). Planigraph at 7 cm. level (relaxation).
Fig. 5-*D* (*lower right*). Planigraph at 7 cm. level phonating "e."

and one-half centimeters (Fig. 5-*A*). On phonating the vowel "e," the whole larynx is raised approximately one-half centimeter and both the true and false cords approximate each other with often only a knife-edge slit to the air passage between (Fig. 5-*B*).

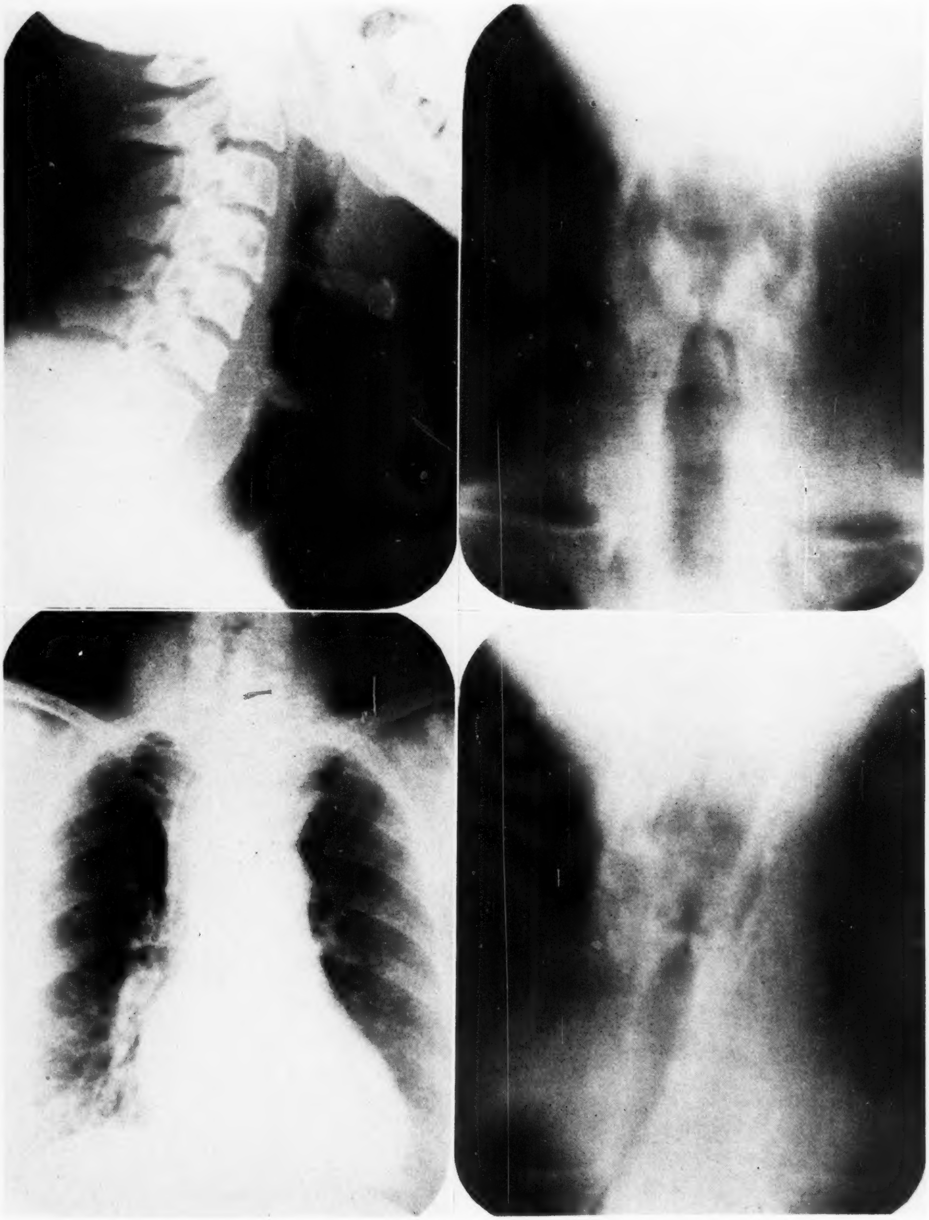

Fig. 6-*A* (*upper left*). Lateral x-ray of neck, lymphosarcoma.
Fig. 6-*B* (*upper right*). Planigraphic section of larynx. Note the soft tissue mass on the left.
Fig. 7-*A* (*lower left*). X-ray of chest showing extensive thyroid tumor.
Fig. 7-*B* (*lower right*). Planigraphic section at 7 cm. level phonating "e."

Posterior Third.—A plane one or two centimeters posteriorly, shows the rounded surface of the laryngeal ventricles which at times fuse with indistinct shadows of the arytenoid cartilages (Figs. 5-*C* and 5-*D*). The true cords do not stand out as boldly

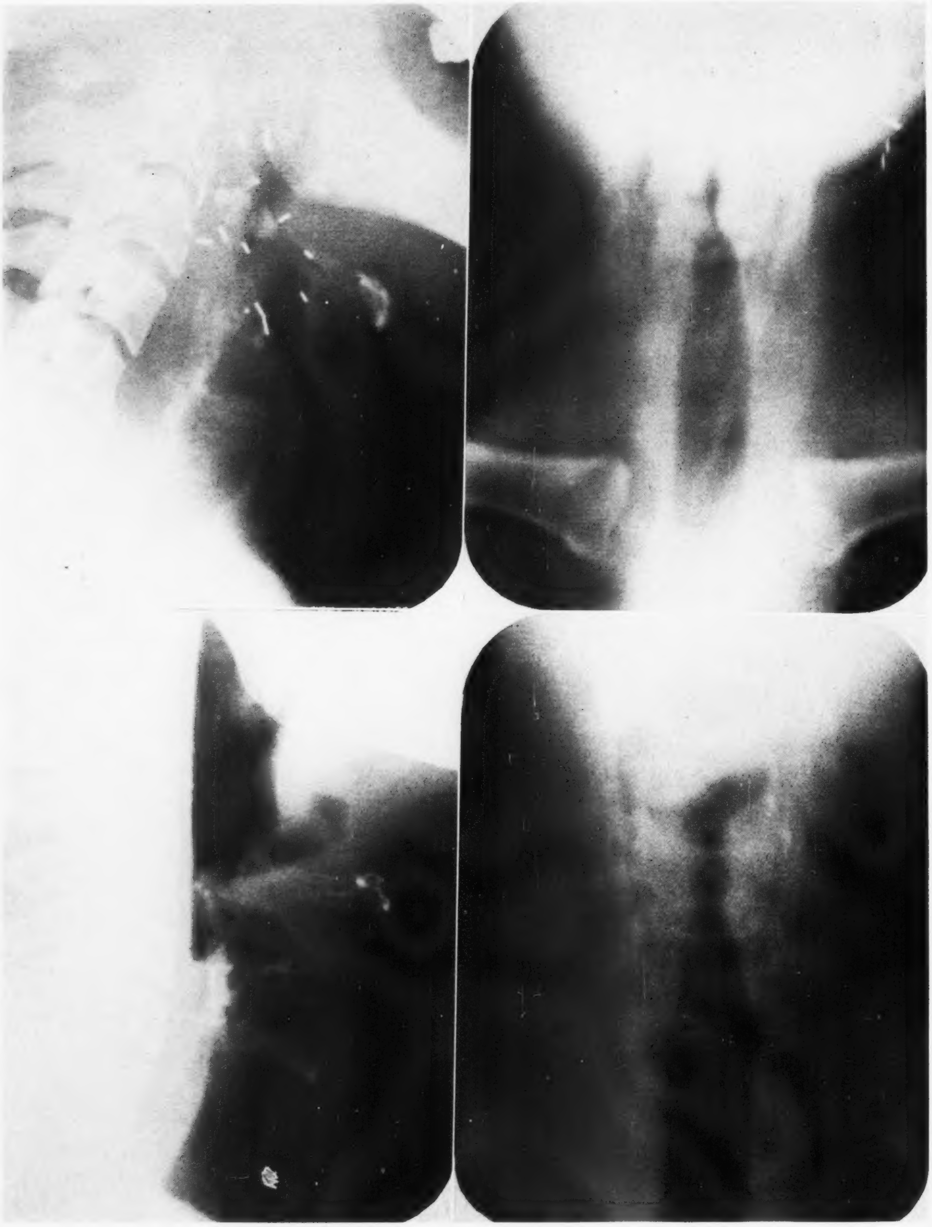

Fig. 8-*A* (*upper left*). X-ray demonstrating broadening of retropharyngeal space.
Fig. 8-*B* (*upper right*). Planigraph at 8 cm. level phonating "e."
Fig. 9-*A* (*lower left*). X-ray demonstrating prolapse of epiglottis.
Fig. 9-*B* (*lower right*). Planigraphic section at 7 cm. level.

and their free surfaces are more rounded; the interventricular fossæ are more shallow. The pyriform sinuses may be narrower at this level.

The next centimeter plane carries posterior to the intrinsic larynx and brings into further detail its cartilaginous boundaries, both intrinsic and extrinsic. The pyriform sinuses make a triangular shadow on either side. The anterior surfaces of the vertebral bodies and their lateral masses are more clearly visualized.

Demonstration of pathology must consist in some deviation from this normal.

Extrinsic pressure, as from enlarged cervical glandular mass, is demonstrated by a patient with lymphosarcoma involving the soft tissues on the right side. This mass has definitely narrowed the pyriform sinus on the involved side, but demonstrates no change in the intrinsic laryngeal structures (Figs. 6-*A* and 6-*B*).

A second case demonstrates deviation and tilting of the larynx and trachea to the right, due to pressure from an enlargement of the thyroid gland. Note the narrowing of the tracheal lumen due to a substernal extension of the thyroid (Figs. 7-*A* and 7-*B*).

Edema and infiltration of the surrounding soft tissues are shown in a case in which there is extension throughout all of the cervical lymphatic glands, secondary to a carcinoma of the tonsil. A lateral view demonstrates broadening of the retropharyngeal space, swelling of the epiglottis, and narrowing of the hypopharyngeal air space (Figs. 8-*A* and 8-*B*). The planigraphic section illustrates an enlargement of both cords with encroachment upon the intraventricular space, particularly on the left.

Another case demonstrates deep ulcera-

Fig. 10-*A* (*upper*). Specimen. Carcinoma of pyriform sinus, right.
Fig. 10-*B* (*lower*). Planigraph at 7 cm. level. Carcinoma filling pyriform sinus, left.

Fig. 11. Paralysis of the right voca cord.

Fig. 12-*A* (*upper left*). Lateral x-ray of neck. Chronic laryngitis.
Fig. 12-*B* (*upper right*). Planigraphic section at 7 cm. level. Hypertrophy of both vocal cords.
Fig. 13-*A* (*lower left*). Lateral neck. Note destructive process from tuberculosis.
Fig. 13-*B* (*lower right*). Planigraph at 5 cm. level phonating "e." Tuberculosis.

tion of the posterior surface of the tongue with marked swelling and prolapse of the epiglottis, due to carcinoma originating in the base of the tongue. The planigraph

Fig. 13-*C* (*upper left*). Planigraph of larynx, 5 cm. level, phonating "e." Tuberculosis.

Fig 14-*A* (*upper right*). X-ray showing soft-tissue changes due to carcinoma of larynx. (Lateral view, Case I.)

Fig 14-*B* (*lower left*). Planigraph at 6 cm. level. Carcinoma mass on right replacing cords. (Case I.)

Fig. 14-*C* (*lower right*). Planigraph at 8 cm. level. Carcinoma of intrinsic larynx. (Case II.)

clearly visualizes the epiglottis as a broad slightly oblique band extending across the laryngeal vestibule with the apparent swelling of the true and false cords, leaving

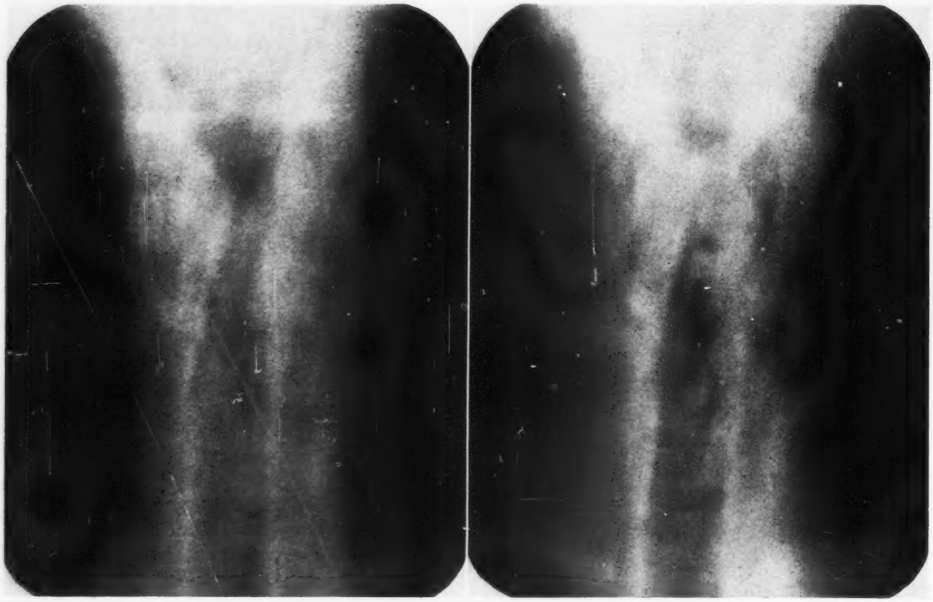

Fig. 15-*A* (*left*). Laryngo-fissure. Removal of the right cord at 7 cm. level, relaxation.
Fig. 15-*B* (*right*). Laryngo-fissure. Hypertrophy of remaining true and false cords, phonating "e."

the intraventricular fossa as only a shallow cleft (Figs. 9-*A* and 9-*B*).

A carcinoma arising in the mucous surface of the left pyriform sinus with a large metastatic gland in the neck, is visualized as a soft-tissue mass, filling the left pyriform sinus. There is swelling of the true and false cords and narrowing of their intraventricular space (Fig. 10-*B*).

Paralysis of the recurrent laryngeal nerve indicative of intrinsic lesions is, of course, usually visualized on mirror examination and can be seen fluoroscopically. It can also be demonstrated on the planigraphic film during phonation, in which instance only one cord becomes erect. The active vocal cord often extends beyond the mid-line to approximate the paralyzed side (Fig. 11).

Chronic laryngitis is demonstrated by hypertrophy and rounding off of the free edge of both vocal cords with a slight asymmetry of the cord (Figs. 12-*A* and 12-*B*).

Tuberculosis can be visualized as a destructive process. In the case shown, the free edge of both cords is seen to be irregular with more destruction on the right than the left side. The false cord on the right appears to be edematous or hypertrophied and appears to come in contact with the upper surface of the left cord. The large ventricular band on the right would hide the vocal cord from view in the usual mirror examination (Figs. 13-*A*, 13-*B*, and 13-*C*).

Carcinoma of the intrinsic larynx may be shown as an ulcerating destructive process or as an overgrowth; the latter is the usual thing. Both cases illustrate a mass replacing the true and false cords on the left, with edema or hypertrophy of the cords on the right, and the loss of the usual intraventricular sinus on the right. The pyriform sinus is obliterated on the left (Figs. 14-*A*, 14-*B*, and 14-*C*).

One case is shown after laryngo-fissure with removal of the right and partial removal of the left cord. The illustration shows the smoothed-off wall of the larynx on the right with no evidence of either cord or of its sinus. The remaining true

and false cords are hypertrophied as shown by their size and the curved appearance of their free margin (Figs. 15-*A* and 15-*B*).

SUMMARY

1. Interest in sectional roentgenography in this country dates from a publication of J. Robert Andrews (1), in 1936.

2. Advantages and disadvantages of this method are summarized in this article.

3. Sectional dorso-ventral views of the larynx are shown in: *a*, normal (1, relaxation; 2, during phonation of the vowel "e"); *b*, pathological (1, extrinsic lesions; 2, intrinsic lesions).

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EXPLORATION OF THE THORAX BY BODY-SECTION ROENTGENOGRAPHY[1]

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DURING the short period of time that body-section roentgenography has been practised, the work of many investigators indicates that the thorax is an especially fertile field for diagnostic contributions by the method. Sectional films have demonstrated the relations of bronchi and pulmonary vessels (Grossmann, 9, 10; Chaoul, 5; Greineder, 8; McDougall and Crawford, 13). Studies of pulmonary tuberculosis with reference to gross distribution of the disease, recognition and localization of cavities, the effects of artificial pneumothorax and thoracoplasty, suggest the frequency with which planigraphy will be used in future roentgen studies of this disease.

Mediastinal and pulmonary tumors have been studied by Moore (14, 15) who predicted the demonstration of intrabronchial tumors by sectional films. Laminagraphs of pulmonary tumors convincingly demonstrate the advantages of body-section roentgenography

Chaoul (5) has suggested that dilatations of the bronchi in bronchiectasis can be demonstrated without the use of an opaque contrast medium.

The demonstration of unsuspected lesions by planigraphy is such a frequent experience with the increasing use of this method that it is almost impossible to formulate rules of thumb for extending the routine examination to include a planigraphic examination. However, the work of other investigators indicates valuable contributions from body-section roentgenography in examinations of:

1. Thoracic skeleton, notably examinations of the sternum and sterno-clavicular joints, lateral views of the dorsal vertebræ when these are obscured by ribs or pulmonary densities, and anteroposterior views of the spine for differential visualization of laminæ, pedicles, and bodies.
2. Pulmonary anatomical relationships of bronchi, arteries and veins, interlobar fissures, and great vessels of the mediastinum.
3. Pulmonary and mediastinal tumefactions.
4. Pulmonary cavities and their localization.
5. Bronchial obstructions, bronchiectasis, and foreign bodies in the respiratory passages.

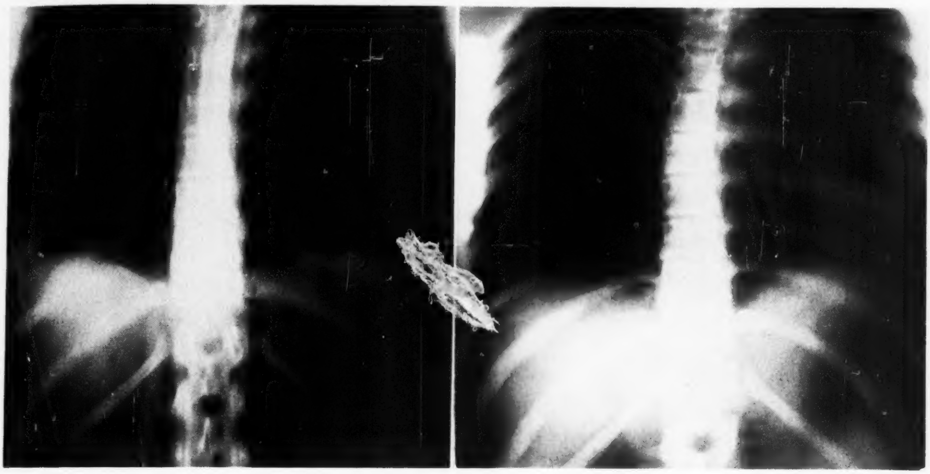
Technic.—The importance of making conventional examinations before resorting to planigraphic studies has been emphasized by many workers. This practice frequently demonstrates the gross localization of the obscure lesion which can then be examined by small serial sections. We have followed this practice to permit more effective use of diaphragms and to reduce the cost of the extended examination. However, as pointed out by Moore, too restricted a field seriously militates against the discovery of an unsuspected lesion.

Three factors are of paramount importance in securing satisfactory results: (1) efficiency of the mechanical linkage between tube and film carriage; (2) satisfactory elimination of obscuring shadows overlying the plane of section, and (3) efficiency of the grid for absorbing secondary radiation.

The efficiency of the mechanical linkage is in part dependent upon the type of motion used for tube-film displacement. Three types of motion are available: linear, curvilinear, and a combination of these two motions resulting in a path with

[1] Presented before the Twenty-fourth Annual Meeting of the Radiological Society of North America, at Pittsburgh, Nov. 28–Dec. 2, 1938.

long linear and short curvilinear components. In all instances the thickness of layer or section is inversely proportional



A B

Fig. 1. Comparison of linear and spiral motions of sections of dorsal spine at a four-centimeter depth. (*A*) Longitudinal linear motion-amplitude, 60 cm. This illustrates thinness of section and asymmetrical blurring, particularly noticeable in the spinous processes. (*B*) Spiral motion-amplitude, 20 cm.—illustrating greater depth of focus and symmetry of blurring.

to the angular amplitude. The character of blurring of shadows in planes above or below the layer "in focus" is determined by the character of tube motion.

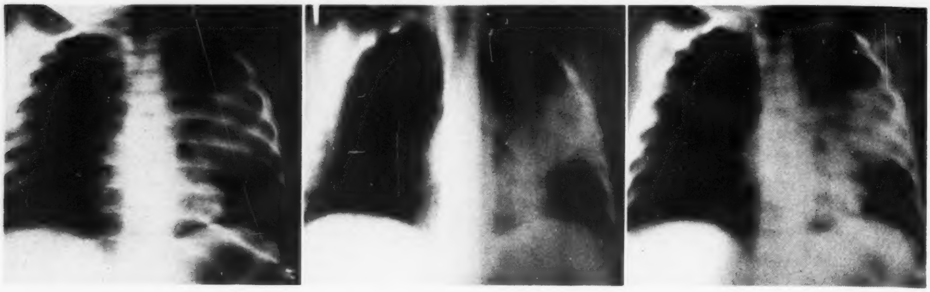
Longitudinal or linear displacement of the tube permits a simple linkage mechanism which can be used with a Potter-Bucky diaphragm. Twining (17) and other workers have shown that this type of tube-film displacement is easily and economically adapted to present conventional equipment. Amplitudes of tube displacement can be varied over a wide range to control the thickness of section and amount of blurring. Since the tube displacement is unidirectional, blurring is asymmetrical. The most effective blurring occurs with shadows lying at right-angles to the direction of motion and least effective blurring with shadows parallel to the direction of motion. In our experience this results in unevenness of film density, and an appearance of linear streaking in the film.

Spiral motion has proved to be the most effective of the curvilinear motions. Perfect mechanical linkage is difficult to obtain with this type of displacement since mechanical play between moving parts tends to be greater than in the case of simple linear motion. This factor reduces sharpness of detail seen in phantom studies comparing the two motions. An amplitude of 20 cm. is about the maximum practical excursion for curvilinear motions. This gives an average thickness of section of 3 mm. as determined by phantom studies and is to be contrasted with one-millimeter depth of sharp focus obtained with linear motion of 60 cm. amplitude.

Extremely thin sections are neither necessary nor advantageous in thoracic planigraphy since they may necessitate a larger number of sections for the complete visualization of vessels or bronchi lying obliquely to the horizontal plane of section. The longer tube displacements do eliminate more effectively the rib shadows, but one must differentiate adequate blurring with a reasonable depth of focus and complete blurring with too thin a depth of

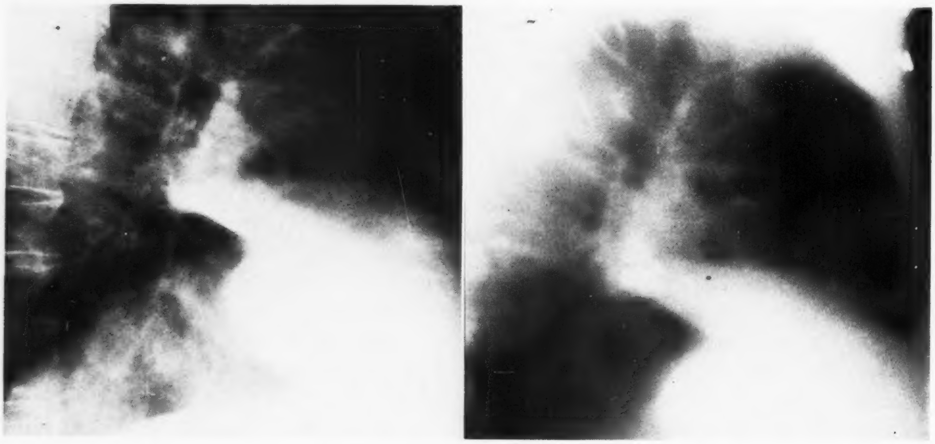
focus to be able to recognize structures partly within and partly beyond the horizontal plane of section (Fig. 1).

second is feasible. Unco-operative subjects, infants, and young children are examined using linear tube motion trans-



A *B* *C*

Fig. 2. Comparison of linear and spiral motions for pulmonary fields. (*A*) Transverse linear motion-amplitude, 20 cm. Exposure time, one-half second. (*B*) Longitudinal linear motion-amplitude, 60 cm. Exposure time, three and one-third seconds. (*C*) Spiral motion-amplitude, 20 cm. Exposure time, three and one-third seconds.



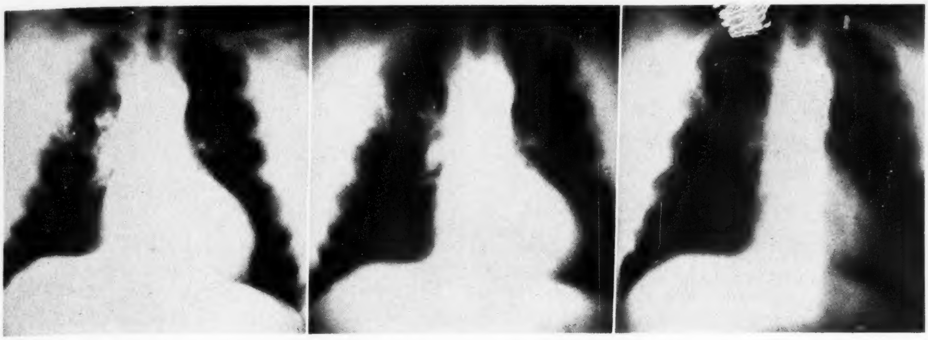
A *B*

Fig. 3-*A*. Conventional lateral chest with Bucky technic in a case of atelectasis of right middle lobe.

Fig. 3-*B*. Section of same case illustrating vascular trunks of posterior, superior, and anterior cones of right upper lobe. Note that the anterior division of the right upper lobe artery extends forward and downward to the triangle of the atelectatic middle lobe. Hilar gland calcification is seen in focus at the apex of the middle lobe triangle.

Exposure time varies with the motion and speed of tube travel. Satisfactory sections of the thorax of a co-operative subject can be obtained with an exposure time of two or three seconds. With some sacrifice in the quality of blurring, an exposure time of from one-half to one

versely across the width of the table. An amplitude of 20 cm. is completed in one-half second. If the direction of tube displacement is made against the direction of the moving grid, a Bucky diaphragm can be used for absorption of scattered radiation (Bush, 4).



A *B* *C*

Fig. 4. Demonstration of pulmonary vascular trunks. (*A*) Section 7.5 cm. below anterior thoracic wall demonstrates branch of right pulmonary artery crossing anterior to right stem bronchus and left pulmonary arterial trunks. (*B*) Section 9.5 cm. below anterior thoracic wall. Right pulmonary artery lies between right eparterial and right hyparterial bronchi. Left pulmonary artery lies above left stem bronchus. (*C*) Section 11.5 cm. demonstrates right and left inferior pulmonary veins entering base of cardiac shadow at a wider angle than that taken by pulmonary arterial trunks. Left superior pulmonary vein faintly visualized crossing left lower lobe bronchus.

Comparisons of films made with linear and curvilinear tube-film motions demonstrate their respective characteristics (Fig. 2). It is advantageous to be able to choose the technic to meet the specific requirements of individual problems. In making such a choice we have found it advisable to consider the relative importance of the following factors:

1. Amount and character of blurring necessary to give adequate elimination of the obscuring shadows.
2. Desired thickness of sections.
3. Desired sharpness of detail.
4. Permissible exposure time.

From an evaluation of the requirements in the individual case, a compromise can then be made in favor of the technical procedure best suited to give the desired information.

Results Obtained by Section Examinations of the Thorax.—Serial sections have provided excellent teaching material of roentgen anatomy of both skeleton and viscera. Class demonstrations are facilitated by reviews of the sectional anatomy followed by study of the more complex superimposed shadows of conventional roentgenograms. We can see much more in conventional films after recognizing images and their relations layer by layer.

The routine practice of making conventional Bucky films under the same conditions as those for sectional films to compare various motions has led to our rediscovery and appreciation of the value of Bucky films. Such films with the subject prone or supine may contribute greatly to the findings of erect instantaneous chest examinations. Sectional films, of course, must be compared with similar conventional technics in order to arrive at a fair evaluation of the contributions of the newer method.

The superimposed shadows of laminæ, articular processes, and vertebral bodies in the dorsal spine constitute an ideal situation for demonstrating the possibilities inherent in planigraphic examination. We have found three or four sections at two-centimeter levels adequate in most cases for satisfactory visualization of these structures. An excessive kyphosis may necessitate a larger number of films or smaller steps between successive sections. Single mid-line lateral sections eliminate ribs and obscuring lung densities from the bodies and pedicles and give good views

of the spinous processes. Additional sections above and below the mid-line are necessary to compare right and left pedicles, articular processes, and intervertebral foramina.

The sternum may require multiple sections when a deformity is marked or an increased angle of Louis precludes positioning the entire structure in a horizontal plane. Our best results have been obtained using linear motion at right-angles to the long axis of the sternum.

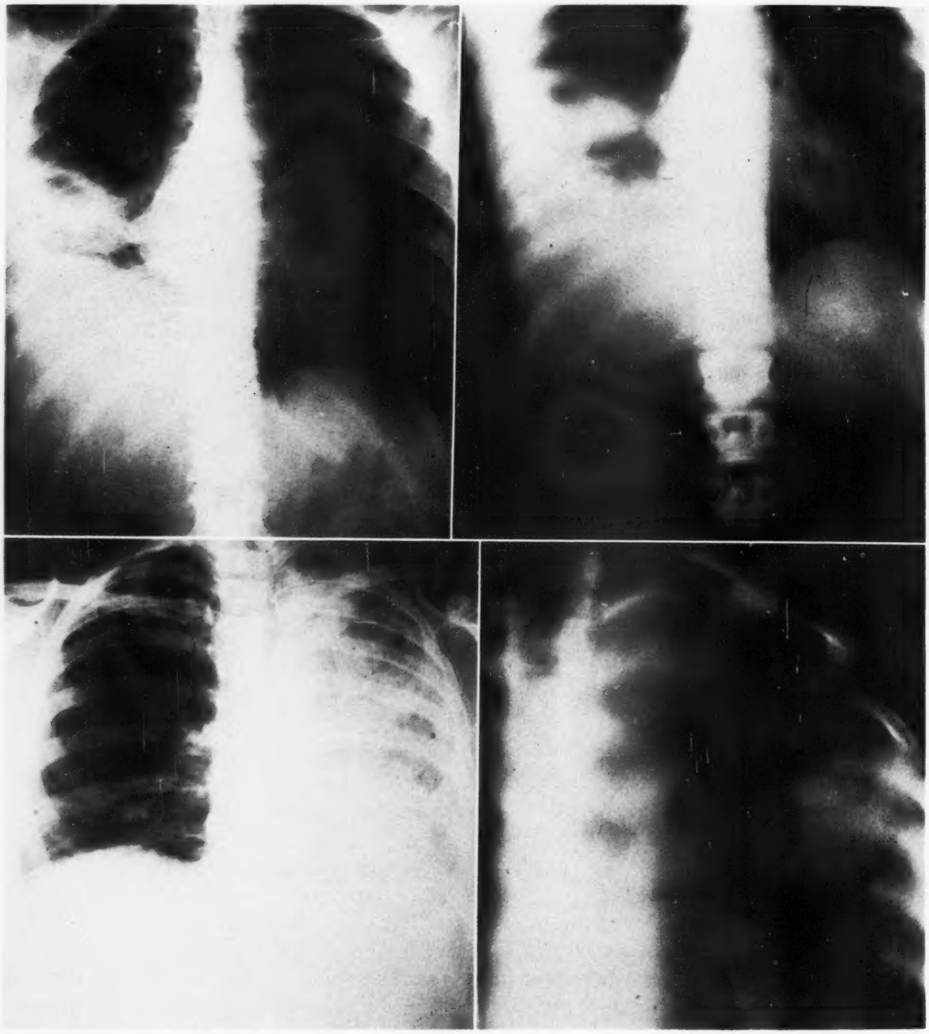


Fig. 5-*A* (*upper left*). Conventional anteroposterior Bucky examination demonstrates pulmonary abscess, pleural effusion, and a small calcific shadow in region of lower pole of right hilum.
Fig. 5-*B* (*upper right*). Planigraphic section of same case demonstrating foreign body. (Tooth within the lumen of right lower lobe bronchus.)
Fig. 6-*A* (*lower left*). Conventional anteroposterior Bucky examination demonstrating atelectasis and extensive pulmonary infiltration of left lung.
Fig. 6-*B* (*lower right*). Mid-line planigraphic section demonstrating polyp of left stem bronchus.

Sectional films of the pulmonary vascular trunks have proved valuable in lobe mapping, as illustrated in Figure 3. The anterior division of the right upper lobe pulmonary artery can be traced from the section of the right upper lobe vessel, forward and downward through the emphysematous upper lobe to the opacity of the atelectatic middle lobe. Calcified hilar nodes are also seen at the apex of the middle lobe triangle.

Frontal sections of the vascular trunks are demonstrated in serial horizontal planes. Figure 4-*A* respresents a plane 7.5 cm. posterior to the anterior thoracic wall. A branch of the right pulmonary artery is seen crossing the right stem bronchus. At a deeper level (Fig. 4-*B*) the right and left stem bronchi are seen. The left superior pulmonary vein crosses anterior to the left lower lobe bronchus and the large inferior pulmonary veins are seen entering the heart shadow at a wider angle than that taken by the pulmonary arterial trunks (Fig. 4-*C*). The left inferior veins are partially hidden by the cardiac shadow. The azygos vein is demonstrated with great regularity as it bends forward above the right upper lobe bronchus to enter the superior vena cava. Its position should be noted and not mistaken for an enlarged paratracheal lymph node.

The contributions from sectional study of non-tuberculous pulmonary lesions are approximately of the same character as in sections of tuberculous lesions. Localization of abscess cavities is of greater surgical importance in non-tuberculous disease and localization by section roentgenography is particularly indicated when conventional lateral projections fail to indicate the position of the lesion. Localization of cysts and cavities deep in the lung aid in the differential diagnosis of pleural shadows, localized pneumothorax, and subpleural emphysematous bullæ.

Two cases of opaque foreign body have been demonstrated in bronchi obscured by the opacity of lung abscesses and associated pleural effusions. One of these, a tooth, is easily identified in the overexposed Bucky film but was considered calcification of a hilar node until a section film demonstrated its location within the bronchial lumen. The second case, with a definite history of choking on a piece of pork bone, was correctly diagnosed only after section examination, and even in retrospect we have been unable to identify the shadow of the foreign body in the overexposed conventional films. We have not yet had an opportunity to explore the tracheobronchial tree for a non-opaque foreign body. Positive identification of some non-opaque bodies should be feasible in the trachea and bronchi.

Pulmonary tuberculous lesions have been so carefully studied by sectional technic by other workers that little can be added at this time. A small group of patients with minimal involvement have been sectioned and one is impressed with the totally different appearance of the parenchymal changes seen in serial sections in comparison with the superimposed shadows of conventional films. Many small areas of decreased density suggest beginning cavitation and early bronchial dilatations. Repeated examinations at intervals and careful correlation of similar shadows in postmortem material may contribute significant information concerning early ulcerative lesions.

The demonstration of an intrabronchial polyp of the type recently described by Graham and Womack as "mixed tumor of the bronchus" has been made by section roentgenography and proved by bronchoscopy and biopsy. The chief complaint presented by this patient was a mass in the epigastrium. Laparotomy was performed and biopsy of retroperitoneal nodes revealed metastatic carcinoma of the same type seen in a portion of the polypoid bronchial tumor (Fig. 6).

Section films of the peripheral pulmonary carcinomas have contributed findings indicative of the infiltrative character of these tumors and the resultant narrowing of the bronchial lumen from peribronchial lymphatic extensions should prove of diagnostic value.

SUMMARY

Preliminary work with apparatus for body-section roentgenography has been carried out in an effort to evaluate the contributions from this technic as applied to the thorax and its viscera. The indications as determined by the work of other investigators are discussed, together with technical considerations of making sectional films with various types of tube-film displacements. Some results obtained in clinical application of the method are discussed.

CONCLUSIONS

1. The desirability of choosing a technic best suited to meet the requirements of individual problems suggests the need for apparatus that will permit the use of both linear and spiral motions of tube and film carriage.

2. The contribution of sectional roentgenograms in demonstrating anatomic relationships offers a new approach to the teaching of roentgen anatomy and diagnosis.

3. The demonstration of unsuspected lesions and additional proof of the presence of suspected lesions by body-section roentgenography of the thorax has established the method as a valuable technic in routine roentgen examinations.

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BODY-SECTION RADIOGRAPHY[1]

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INTRODUCTION

FOR reasons which will be given later, I have chosen as a title for this communication the term, *Body-section Radiography*. The fundamental principle involved lies in the mathematical laws of light and optics. If an object is placed in the path or beam of visible light, a shadow is recorded. If the recording medium and the light are made to move synchronously in opposite directions about a fixed axis, the shadow of the object will remain constant in size and in relationship to the source of light. If another object is placed in the beam of light and out of the plane of rotation of the light and the recording medium, its shadow will be inconstant in size, definition, and relationship to the source of the light.

The principle involved in visible light necessarily applies to invisible or x-light. It was obvious that sooner or later this principle would be applied to the use of x-rays. Bocage (1) is justly credited with designing a method of a co-ordinated movement of a source of x-ray energy and a recording medium. He began his work in 1917 and made application for a patent in June, 1921.

Review of the Literature.—Body-section radiography is relatively new, but an extensive literature already exists. This is strikingly complex, and difficult to understand. Many writers on the subject, by whatever name they have chosen to call it, have described one or more somewhat related procedures under one heading in one article, thereby greatly confusing the reader. Understanding of this subject is not made any easier by the conflicting, often acrimonious, claims made for priority in devising and bringing to practical application the several methods which underlie body-section radiography.

I have reviewed this literature and have concluded that the study by J. Robert Andrews (2) is such a masterly exposition that I will not attempt to add much to it. Such is the conflict of claims for priority that I quote the following excerpt from Andrews' article:

"I have learned . . . . that Mr. Jean Kieffer, of Norwich, Connecticut, independently discovered the principle of body-section roentgenography and invented an apparatus for its application. The apparatus was invented in 1929, at which time a patent was applied for in this country. This patent was granted in 1934. The invention of this apparatus in 1929, therefore, takes precedence over the work of Vallebona, Ziedses des Plantes, and Grossmann."

In the literature I have found but six important articles on the subject of body-section radiography since the appearance of Andrews' article, November, 1936, the first in American literature. These are:

"Tomography," editorial in the *British Medical Journal* of Nov. 27, 1937 (3);
"Report on the Clinical Value of Tomography," at a meeting of a section of Medicine at the Royal Society of Medicine, November, 1937 (4);
"Tomography," McDougall and Crawford, *American Review of Tuberculosis*, August, 1937 (5);
"Essais de Planigraphie," Delherm and Bernard, May, 1937 (6);
Bernard, Etienne, April, 1937 (7);
Twining, E. W., April, 1937 (8).

One of these papers merits close attention—the article by Twining. He describes a very simple device, applied to a standard x-ray table, which moves the tube

[1] Presented at the Twenty-fourth Annual Meeting of the Radiological Society of North America, at Pittsburgh, Nov. 28–Dec. 2, 1938.

stand and Potter-Bucky diaphragm in synchronism and in opposite directions. At the time of publication of his article, claims priority over all subsequent workers in the field.

In 1930, Vallebona made practical clini-

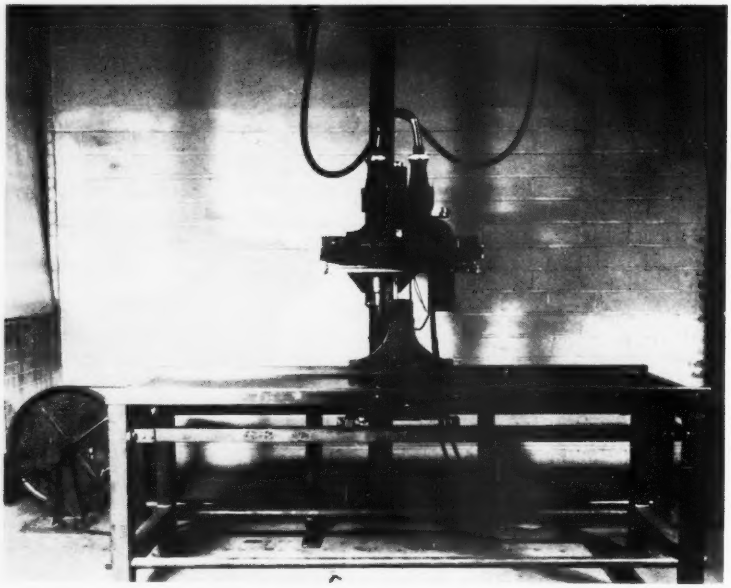


Fig. 1. Photograph of laminagraph.

motive power for this movement was supplied by hand.

Chronological Development of Body-section Radiography.—As far as this writer has been able to ascertain, the work of Bocage, from 1917 to 1921, was purely theoretical. Chronologically, the next endeavor was that of Portes and Chausse, who made application for a patent in October, 1921. They, like Bocage, do not seem to have made any practical application of the principle. Later, in 1927, Pohl did similar work.

Mayer asserts that he introduced, in 1914, the use of a moving tube, in the examination of the heart only, the x-ray negative remaining stationary. Because of the close proximity of the negative to the heart, the image of the heart was freed of overlying shadows and its image was only slightly distorted. On the basis of this he cal application of the synchronized movement of the tube and film, and then elaborated on this principle, in the examination of the thorax, by keeping the tube and film stationary and rotating the patient on a revolving platform. He called this method, at the suggestion of Busi, "stratigraphy."

B. G. Ziedses des Plantes published his work on the use of a synchronized moving tube and film with travel in an Archimedean spiral in 1931, and called his method "planigraphy." It should be stated that Ziedses des Plantes claims he began his work on planigraphy in 1920, 1921.

Grossmann and Chaoul devised, in 1935, an apparatus with synchronized movement of tube and film, with a pendulum action in which the tube describes an arc. They termed this procedure "tomography" and the apparatus a "tomograph."

Kieffer, of Norwich, Connecticut, devised independently an apparatus embodying the underlying principle in 1928, and in 1929 applied for a patent. He called his design an "x-ray focusing machine."

It seemed that the Kieffer apparatus not only would be more efficient in the dispersion of overlying and underlying shadows, but also it appeared to approximate more nearly the mathematical ideal which would be represented by the movement of the tube and film over the surface of a sphere.

The arcuate movement of the tomograph is approximated in the Kieffer design by the longitudinal travel of the tube and film in the "long motion," with the advantage that it is combined with a transverse movement of varying excursion. Furthermore, the Kieffer apparatus has circular and spiral movements, either of which could be used independently or substituted for the transverse movement in the longitudinal travel.

Definition of Terms.—I was at a loss to find a suitable name for the Kieffer apparatus. To speak of it as a *stratigraph, planigraph,* or *tomograph* would not be in accordance with the facts. Furthermore, consideration of other workers in this field made it unfair and unjust to them to apply their terms to a radically different piece of apparatus. Therefore, I coined the term *laminagraph* to apply to the Kieffer apparatus, as it would not infringe on the rights of others. *Stratigraph* (Vallebona) has geological connotations. *Planigraph* is open to the objection pointed out above. *Tomograph,* a type of apparatus different from the foregoing, has been adopted as a trade name. *X-ray focusing machine* has been referred to above. So it seems that *laminagraph* is a suitable name for this particular type of apparatus.

Andrews recommends *planigraphy* as a general term for body-section radiography because of its "temporal precedence." I also have advised elsewhere the use of this term, but subsequently changed my views. Later I thought *body-section radiography* would be a preferable general term. This is adopted from Andrews and is being used as the generic term.

Description of Laminagraph (Fig. 1).—The laminagraph is a sturdily built table and rail-mounted tube stand of conventional type. The tube stand carries a platform on which are mounted a track for universal tube movement in a plane, a revolving disc containing a spiral cam, and suitable slots for employing a spiral, circular, or transverse movement to the tube which is driven by a motor of multiple speed. A cross-arm leads from the disc to the tube carriage and imparts the required movement to the tube. Another cross-arm from the tube carriage connects with a rigid link which passes down to the film holder. This arm transmitting the tube movement to the film carriage passes through an adjustable fixed point in such a way that movement of these two structures is in synchronism and in opposite direction. A cone effect is secured by adjustable moving apertures immediately below the tube, and a wafer type of grid is above the film holder on the film carriage. The grid is so arranged as to travel in only one direction, so all the secondary rays are not eliminated by the grid

A word about the movements in the laminagraph. There is a circular movement of tube and film of seven degrees of amplitude. The spiral movement differs from that of Ziedses des Plantes' apparatus which is Archimedean. Ours is an inverse logarithmic spiral which should insure a more uniform dispersion of shadows. There is a simple transverse movement of tube and film which has not been used clinically. A longitudinal movement of tube and film, combined with a transverse movement, produces a sine curve of the x-ray beam. Further, the long movement of the tube can be combined in a compound movement with the circular or the spiral movement, but there is no advantage in so using them.

Diaphragming at the tube, the cone effect was a very troublesome problem, but I believe this has been satisfactorily solved.

The minimum thickness of layer which can be laminagraphed is of the order of

from 2 to 5 mm. The thickness of layer can be increased by decreasing the excursion of tube and film carriage according to the pathologic condition of the anatomical region under investigation.

SELECTION OF CASES FOR BODY SECTION RADIOGRAPHY

Body-section radiography is not to be employed indiscriminately, nor as a sub-

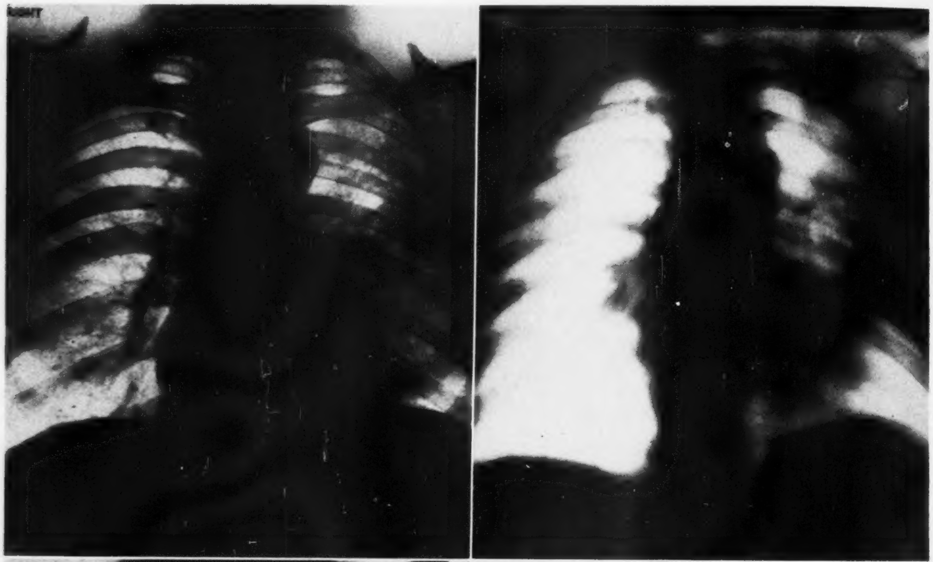
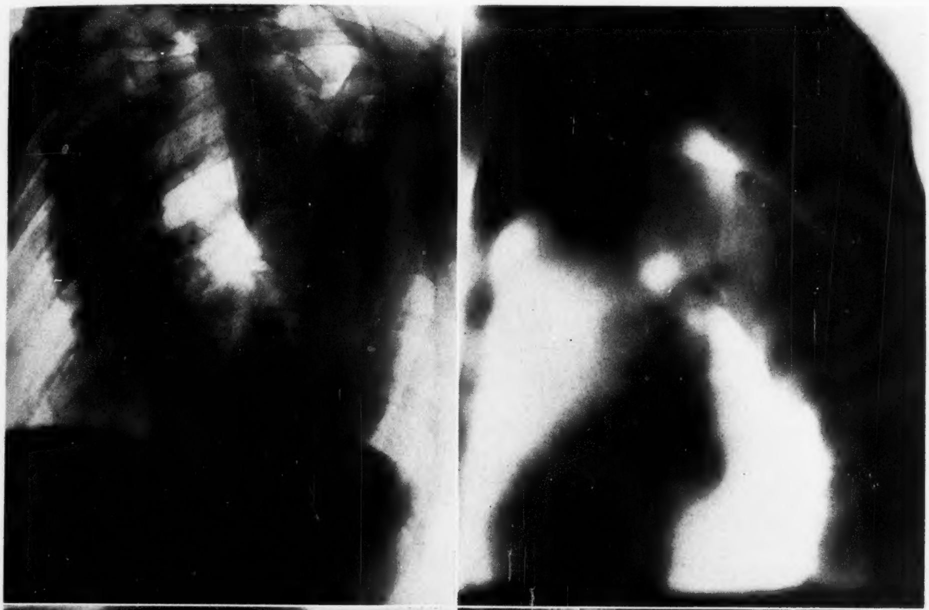


Fig. 2 (*upper left*). Conventional film of chest: (*upper right*) Laminagraph of preceding. Note large cavity, left lung.

Fig. 3 (*lower left*). Conventional film of chest. Note area of opacity: (*lower right*) Laminagraph of preceding showing bronchial occlusion.

stitute for other forms of examination, either physical or radiologic.

(a) *The Fields in which the Laminagraph has not been Employed.*—Laminagraphic studies have not been made in the investigation of the alimentary tract, either with



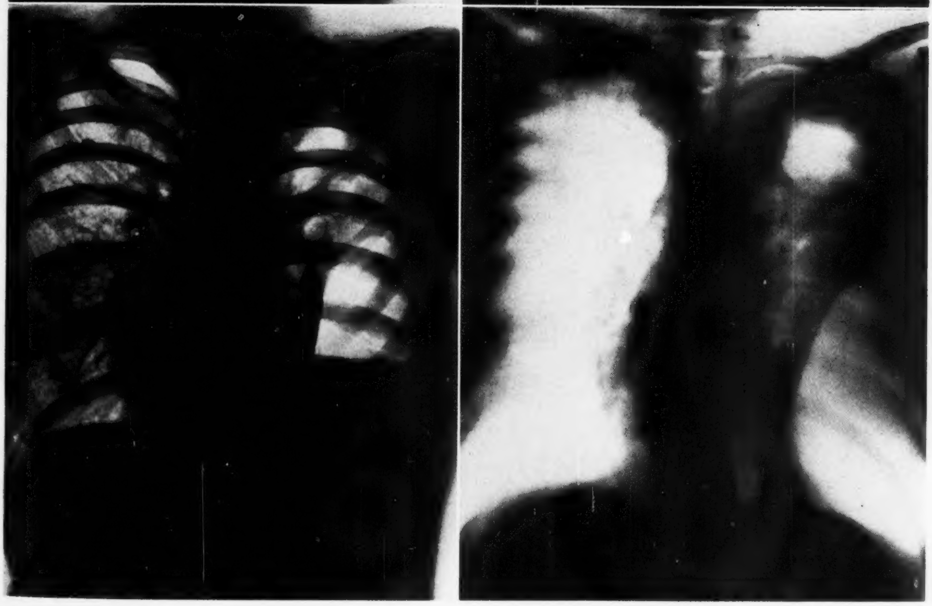


Fig. 4 (*upper left*). Left lateral oblique: (*upper right*) Laminagraph of preceding showing aortic enlargement.

Fig. 5 (*lower left*). Conventional view of chest. Therapeutic pneumothorax: (*lower right*) Laminagraph of preceding showing large cavity in the uncollapsed upper lobe of lung.

or without the opaque meal. They have been applied on occasion to the urinary system, but have contributed little. It must be said, however, that the presence of calcifications in this system might be determined when it is impossible to do so with standard procedures. The exact location and true nature of such a calcification might be determined accurately. In this connection we have demonstrated the presence of aneurysmal sacs, one of the lower thoracic and one of the abdominal aorta, because of the slight degree of calcification in the walls of the sacs.

We have not employed this apparatus in either encephalography or pneumoventriculography for the reason that the method did not seem to promise anything. Twining has found his method of body-section radiography of value in pneumoventriculography.

(*b*) *The Fields in which the Laminagraph has been Employed.*—In body-section radiography shadows of overlying and underlying structures are not eliminated completely. A quantum of shadow, depending on the distance from the plane investigated, is always present in the resultant film.

Fig. 6. Laminagraph of first and second cervical vertebræ. Note ablation of occipito-atlantal joint on the right.

(1) *The Respiratory System.*—Body-section radiography, irrespective of apparatus used, has its chief value in the study of the respiratory system. (The upper respiratory tract will be referred to later.) Grossmann, McDougall, ourselves, and others have demonstrated clearly the tracheobronchial and the pulmonary vascular trees in normal individuals.

In pathologic conditions in the lungs, the presence of cavities, tumors, and areas of atelectasis, not demonstrable by standard radiography, has been shown clearly by laminagraphy (Fig. 2). This fact has been shown beautifully by Grossmann and particularly by McDougall.

I believe that the *absence* of tumors, areas of atelectasis, and cavities can be established with equal accuracy.

Dislocations, obstructions, or occlusions, of even rather small bronchial tubes, can be shown (Fig. 3).

Janker[2] has demonstrated the presence of laryngeal cancer, and it is not too far-fetched to expect that intraluminal neoplasm might be shown, certainly in the major branches of the bronchial tree.

The mediastinum can be investigated effectively with body-section radiography, and the existence and true nature of abnormal conditions revealed in a way which hitherto has been impossible (Fig. 4).

As a guide in the therapy of intrathoracic lesions, whether surgical or medical, body-section radiography is invaluable, and a far better selection of cases for apicolysis or thoracoplasty can be made (Fig. 5).

The approach to pulmonary or pleuropulmonary abscesses is of greatest advantage to the surgeon, as the location, size, and physical characteristics of such abscesses can be determined accurately.

The presence of bronchiectasis can be determined in cases in which bronchography is inconclusive, or in regions where it is not effective. Differentiation between bron-

[2] British Med. Jour., Nov. 27, 1937.

chiectasis and cystic disease of the lung can be made. There is every reason to suppose that endobronchial foreign bodies, non-opaque, may be revealed when they cannot be found with standard radiographic examinations.

(2) *Axial Skeleton.*—Our experience with the axial skeleton indicates that this method of body-section radiography is invaluable in certain regions. These are the cervical spine (Fig. 6), the temporal bone, the nasal accessory sinuses, the temporomandibular articulation, the sternum, certain examples of lesions of the ribs, and the lateral examination of the dorsal spine (Fig. 7). However, it is not so valuable in the examination of the lumbar spine as it is in the dorsal vertebræ.

In the calvaria the laminagraphic examination has been of little aid. However, in the visceral portion of the skull, this means of examination has been invaluable. The pneumatic structure of the temporal bones can be examined advantageously in certain cases. The petrous portions of the temporal bones are demonstrated admirably in an approximately vertical direction in suitably made vertico-submental laminagrams, and in this projection the foramen magnum, the occipital condyles, and the odontoid process can be shown clearly.

The canals connecting the auditory meatuses can be shown throughout their extents, and the relative size of the meatuses can be compared with each other or with their fellow of the opposite side. This has been done in one example of bilateral eighth nerve tumor.

Many of the openings in the base of the skull can be isolated and shown clearly with properly made laminagrams. So far, we have not encountered a pathologic alteration in any of these passages.

In our clinic there is a very active oral and plastic surgical service, and, in addition, marked interest in the temporomandibular syndrome. In consequence of this, there has been a fairly large experience

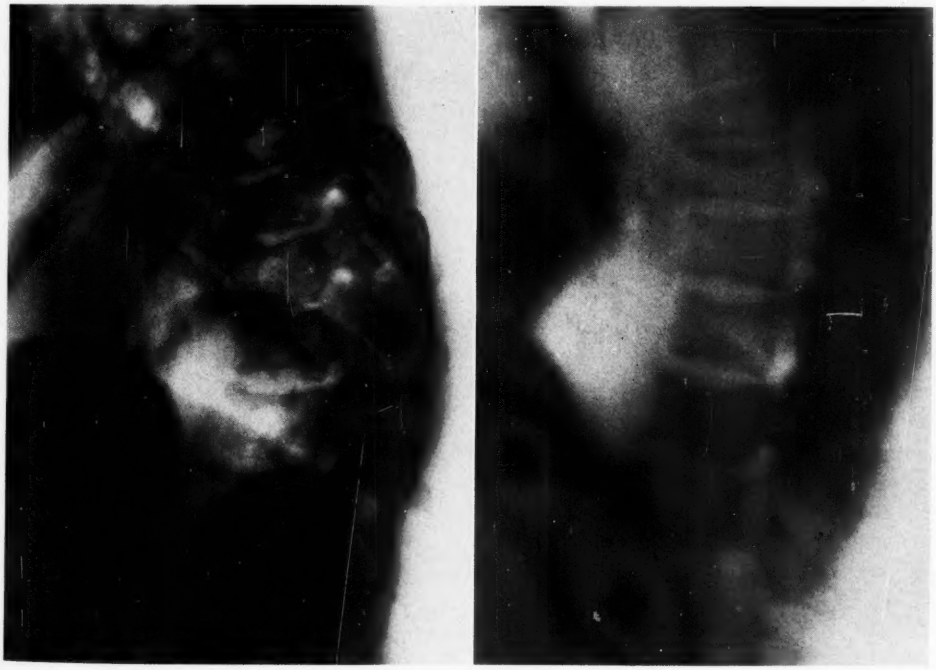


Fig. 7 (*left*). Conventional lateral view of dorsal spine: (*right*) Laminagraph reveals collapsed vertebra.

with the examination of the temporomandibular joint, the most active of all articulations, and laminagraphic examination has proved invaluable in its study (Fig. 8). Fractures and pathologic processes in this joint have been shown that otherwise would have been undiscoverable.

In the examination of the sella tursica we have had little or no improvement over conventional examinations of this structure, in contrast with the opinion of others. The reason for this is the fact that superimposed structures, that is, the images of the lateral walls of the skull, are thin and, therefore, are largely eliminated in the stereoscopic films taken of this region. However, the underlying sphenoid antrum, and, therefore, the floor of the sella, can be delineated clearly in either the lateral or the frontal direction, and its condition very accurately ascertained.

Before leaving the question of this portion of the axial skeleton, I wish to say that

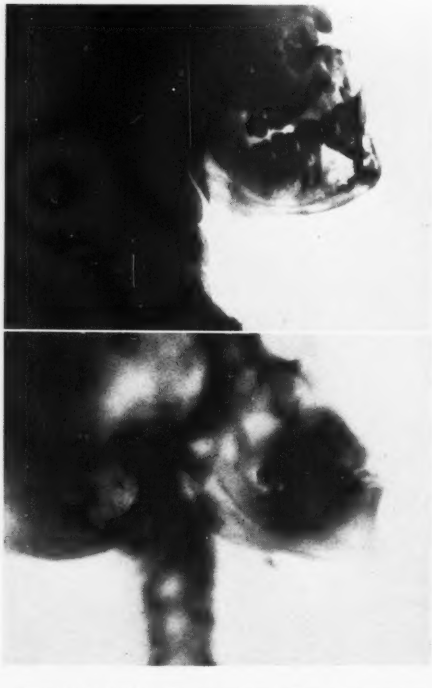


Fig. 8 (*above*). Conventional film of temporomandibular joint: (*below*) Laminagraph of preceding showing fracture of neck of condyle.

we have not experienced any striking advantage in the examination of calcified intracranial tumors.

(3) *Appendicular Skeleton.*—Body-section radiography does not have the possibilities in pathologic diagnosis in the examination of the appendicular skeleton that it has in certain regions, for example, the thorax. The reason for this is that there is little superimposition of structures, and radiographic examinations in perpendicular planes, with the exception of the limb girdles, can be made readily and satisfactorily. However, small central lesions in bone otherwise invisible, such as a tumor, can be shown in this way. In cases in which there is superimposition of structures, for instance, an avulsion fracture about a joint, the presence of small fragments of bone can be determined.

Laminagraphic examination of the sacrum, with its articulation with the pelvic girdle, promises to be of value, but so far we have not succeeded in discovering any pathologic or traumatic condition of the joints in question which have not been revealed by other methods.

There is, however, in the appendicular skeleton, an invaluable application of body-section radiography, namely, the examination of a limb through retentive apparatus; for example, the examination of fractures through a plaster cast to determine alignment.

Technic.—The first requirement in technic for laminagraphic examination is the selection of suitable cases—what constitutes a suitable case has been implied already. There should be standard x-ray films as a preliminary. From these, the method of placing the patient, and the depth at which to start the series of laminagrams can be determined. For example, a standard radiographic examination of the thorax in the anteroposterior and lateral views should be made. From them, the suspected area is measured off on the film, and the patient placed in the prone or supine position, depending on whether the suspected area is anterior or posterior. If the suspected area is ad-

jacent to the mediastinum, the same procedure is gone through, with the patient placed on the side indicated. The object in this type of examination, as in all others, is to have the zone under scrutiny as close to the film as possible, for no method of body-section radiography eliminates the factor of distortion or lack of detail because of the distance of the object from the film. Serial laminagrams are then made through the entire thickness of the suspected area; in the thorax, at a minimum of every centimeter, though the thickness of layer can be varied if desirable. In cases in which small structures, such as the temporomandibular joint and certain foramina in the base of the skull, are being examined, laminagrams at levels of a few millimeters are made.

The dispersion of the shadows of overlying and underlying structures is dependent upon the amplitude of the excursion of the tube and film and on the distance the layer under investigation is from the film. Accordingly, by the method of trial and error, the type and amplitude of movement is varied to suit the particular case.

Film and intensifying screens are standard. Target-film distance is dictated by the grid ratio. The focus of the tube is important. We have employed a line-focus tube, and the tube is made to tilt in order to secure an even intensity of light at every point on which it impinges on the object and the object and the film.

Voltage requirements in body-section radiography are identical with those of standard radiographic examinations. The time of exposure, current, and movement of the laminagraphic system are interdependent. Our laminagraph is connected to a mechanically rectified transformer of low capacity. This fact has greatly modified our technic of exposure and required more time than would be necessary with a large capacity valve tube apparatus. In this connection, it must be stated that Grossmann makes great point of the length of exposure required in all movements of the several methods employed in body-section radiography, except in tomography. Our experience does not substantiate his opinions which, however, were theoretical rather than a result of practical experience. He is of the opinion that rapid exposure is impossible except in the arcuate movement of tube and film, and he claims that for spiral or circular movement very long exposures are required—up to 15–20 seconds.

The laminagraph can be operated at sufficiently high speed with either the circular or spiral movement, far beyond the capacity of the transformer now in use. In the longitudinal movement, which we have employed to a very limited extent, exposures have to be rather long, as this movement is secured by counterweights at present. Longitudinal movement can be brought about by motor drive with much increase in speed.

Of all the movements used in the laminagraph, the spiral has been the most satisfactory. And this is as it should be, because mathematically there is a much more symmetrical type of dispersion or blurring of unwanted shadows. Laminagrams of the chest have been made in as short a time as one second with the spiral motion.

In summing up the question of technic in body-section radiography, I think it can be stated that though it seems very complicated and difficult, once a little experience has been gained, and with sufficient transformer power, body-section radiography will be no more difficult than other standard radiographic procedures.

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SUGGESTIONS FOR THE IMPROVEMENT OF ILLUSTRATIONS

PART I.—FROM THE PHOTOGRAPHER

By A. TER LOUW, *Rochester, New York*

IT goes without saying that a photograph used to illustrate a scientific article or textbook must show clearly the desired features of the subject or there is no point in reproducing it. Unfortunately, however, medical photographic illustrations are sometimes remiss in this respect. The causes for this failure are various; sometimes they can be attributed to the photographer and sometimes to the author, while on other occasions the photo-engraver or the publisher is to blame. Our present purpose is to discuss the responsibility of the photographer in producing effective photographs for medical illustration. We shall approach this from two aspects, the esthetic and technical.

Esthetic Matters.—Photography of medical subjects is a relatively simple procedure so far as the mechanical operations are concerned. Procedures for the situations most frequently encountered have been described. By following these instructions almost anyone can take suitable apparatus and produce negatives that are correctly exposed and developed and show the details of the subject sharply in focus. Then, with a little practice, he can produce prints of good technical quality. It does not follow, however, that the pictures thus produced will be satisfactory as illustrations for articles or textbooks. More than technical perfection is needed to make an effective medical illustration. Artistry is as essential in photographing a medical subject as in painting a portrait.

Planning the Picture.—Good medical photographs require forethought and planning and demand close co-operation between the physician for whom the picture is being made and the photographer. Before the actual photographic operations begin, the photographer should acquaint himself with the characteristics of the subject and the purpose for which the pictures are being made. He should ascertain definitely just what aspects of the pathologic condition are to be recorded. Will a view be required to show the anatomical location and extent of the area involved? Should a close-up be made to show details of the lesion? If so, is the distinguishing feature a color difference or surface texture? Is the present picture to be followed by others showing progressive changes? If the subject is a pathologic specimen, it is important to know how it was oriented in the body and what anatomical features are to be emphasized.

This information is essential in order to answer the first question which arises in planning the photographic study—How many views will be required and at what scale will they be made?

When deciding this point, both the photographer and the physician should have a clear idea of the requirements and limitations of the various ways in which photographs may be displayed or utilized. As an example, let us consider a patient suffering from ulcerating cancer of the breast. An anterior view of the upper half of the torso when displayed as an 8×10 in. transparency might show all the important features—relative size of the normal and affected breasts, location and extent of the lesion, and also details of the lesion itself. However, if this same photograph were reproduced as a 2.5×3.5 in. cut in a scientific journal, only the general aspect would be presented. Details of the lesion would have to be shown in a second reproduction in which the pathologic area appears at a larger scale. It is important, therefore, that those concerned with the production of medical illustrations be able to visualize clearly the appearance of the end-result when planning their pictures.

In most cases, it is impossible to predict at the time the picture is being made in which of the various ways the photograph may subsequently be employed. However, since the greatest losses of quality and definition are likely to occur when the photograph is reproduced photomechanically, it is a good policy to give special consideration to the requirements of publication. Although a certain amount of the loss of definition under these conditions can be attributed to the limitations of the reproduction processes themselves, in journals of high quality by far the greatest loss is brought about by the reduction in size. The magnitude of this effect can readily be estimated by using a reducing glass. By varying the distance between the glass and the photographic print its approximate appearance at various degrees of reduction can be observed.

With the essential information at hand, the photographer is ready to begin the operations preparatory to making the exposure—posing the subject, arranging the lights and background, and selecting the point of view and scale size. It is at this time that the effectiveness of the photograph is determined, for, unless the picture is properly composed before the exposure is made, little can be done subsequently to convert it into a really good medical illustration.

Composition.—Composition in pictures relates to the arrangement and balance of lines, masses, and tones. It is impossible to say that one particular arrangement is good and another definitely bad. However, in general, it is agreed that a picture is well composed when all its parts seem to fuse into a harmonious unity, all parts being subordinated to the feature of major interest so that the attention is naturally directed to this point.

In pictorial and illustrative photography, principality of the major feature is sometimes accomplished by producing strong differences in light and shade through lighting effects, or by suppressing detail in certain parts of the subject. These methods are hardly practicable with medical subjects since good definition in all parts of the picture is most desirable. Principality must then be obtained by arrangement of the subject matter within the picture area and judicious choice of scale size.

One of the fundamental rules of composition is: Each picture should have a single point of major interest. Many medical illustrations are deficient in this respect because the photographer tried to include too much. Each view of the subject should be made with the intention of presenting most effectively one piece of information about the subject. One of the chief methods of doing this is to compose the picture so that the area of interest occupies a major portion of the picture. When this is done the details stand out clearly and there is little opportunity for adjacent anatomical features to draw the attention away from the center of interest.

This principle should not be carried too far, however, especially in close-ups. Whenever possible, enough of the body area should be included to permit anatomical orientation of the pathologic area.

Another general rule of composition warns against placing the major point of interest in the geometrical center of the picture. This applies especially when lines or strong tonal contrasts are the major elements of composition. In medical pictures, however, the emphasis on texture and detail makes it generally advisable to keep the area of interest somewhere near the center of the picture.

A suitable background is another important factor in making effective pictures. All too often we see medical photographs in which the office furniture is more in evidence than the subject itself. The background area should be kept as unobtrusive as possible. The following suggestions will be helpful in attaining this:

(1) Select a plain background of uniform tone somewhat darker than the subject. (Dark gray or black gives the least trouble.)

(2) Place the subject three or four feet in front of the background. (This tends to eliminate a sharp shadow pattern which is frequently distracting.)

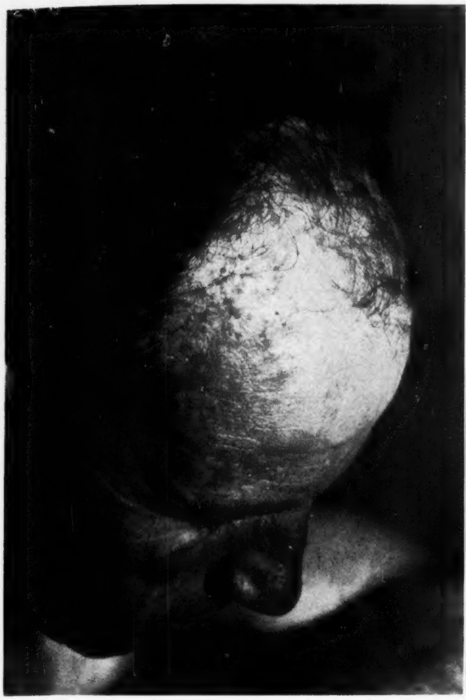

Fig. 1.

Fig. 2.

Fig. 1. To improve this picture: Move the lights so that the strong highlight will not fall within the area of interest. Use orthochromatic film, or a panchromatic film with a green (Wratten No. 58) filter, to enhance the faint color difference between the lesions and the surrounding skin. This photograph was made with panchromatic film and no filter.

Fig. 2. To improve this picture: Pose the subject so that the chair will not be visible. Illuminate the background so that there will be a distinct contrast between the tone of the background and that of the subject. Move the subject farther away from the background to eliminate the shadow pattern. Remove the clothing to the waist and cover it smoothly with gray sheeting. Move the reflector at the right so that it will not appear in the picture or cast a shadow on the background.

(3) Pose the subject and compose the picture so that a minimum area of the background will appear in the reproduction.

Closely associated with background treatment is the draping of the patient. Many times it is necessary for the subject to disrobe partially. This invariably produces an untidy appearance, which proves very distracting if it is reproduced in a picture. Often this can be remedied by careful composition or by smoothly covering the disheveled clothing with dark sheeting. On other occasions the only satisfactory way is to disrobe the subject completely. The general appearance of the patient being photographed for medical purposes should be given as much consideration as if he were having his portrait made; his hair combed, his face shaven, and traces of adhesive tape cleaned up.

Progress Photographs.—Series of pictures showing changes over a period of time are common in medical photography and require special attention. It is desirable to have an entire series as uniform as possible so that changes in the pathologic area are not confused with differences in photographic treatment. To do this it is necessary for the photographer to visualize the appearance of the final picture of the series and then select the scale size and point of view for the first picture with this in mind. Throughout the entire series he should maintain a uniform technic with reference to the following factors:

(1) Composition and Scale Size: Each

Fig. 3. Fig. 4.

Fig. 3. To improve this picture: Use a darker material for the background. Extend the background drop so that it will cover the foot which appears out of focus. Compose the picture so that the large lesion is placed farther up in the picture area. At the same scale, the heel will be within the picture and the location of the lesion indicated.

Fig. 4. To improve this picture: Compose it so that the arm is parallel with the long dimension of the picture. Select a scale size at which the arm will be shown from the elbow joint to the second joint of the thumb. Use a plain, dark gray background. Use orthochromatic, or panchromatic film with a green (Wratten No. 66) filter to emphasize slightly the color differences in the lesion.

Note.—The camera lens should be at least 18 inches from the arm to give proper perspective.

picture should be made from the same viewpoint, and the patient should be posed in the same manner each time. Uniformity should also extend to clothing and drapes.

(2) Background: The tone of the background should be the same throughout a series. (The use of a black background simplifies this problem.)

(3) Lighting: The same system of lighting should be employed throughout a series.

(4) Optical Factors: A lens of the same focal length should be used for each and the same diaphragm setting.

(5) Sensitized Material and Color Filter: A change in the type of film or color filter employed will seriously affect the value of a progress series.

(6) Contrast of Negative and Print: The relation between the contrast of the subject and the contrast of the photographic print should be kept as nearly constant as possible. Consistent use of the same film and development procedure will lead to negatives of uniform quality from which it is a relatively simple matter to make a set of matched prints.

In cases in which color differences are an important feature, it is advisable to include a scale of grays in the picture area. This will serve as a guide in matching the prints. If the scale is placed so that it appears near the edge of the negative, it can be eliminated in reproduction.

Technical Matters.—One of the commonest causes for poor technical quality of medical illustrations is failure to follow the manufacturer's recommendations. It will be found that adoption of standardized procedures based upon information worked out by experts will lead to great savings of

time and materials and a distinct improvement in the quality of the results.

Definition.—Needle-sharp definition throughout the area of interest is of primary importance. Following are some of the factors which affect the rendition of fine detail.

(1) Quality of the Lens: In some fields of photography a "soft-focus" lens may be desirable, but not in medical photography. For really fine medical illustrations an anastigmatic lens of the finest quality should be employed. In passing, it should be emphasized that even the best lens cannot produce a sharp, brilliant negative if it is dirty. An efficient lens hood is advisable if the optimum performance of a lens is desired.

(2) Focusing and Depth of Field: Maximum over-all sharpness is obtained by using a small lens aperture and focusing to make the most advantageous use of the available depth of field. It is common practice to focus on the subject with the lens at full aperture and then close the diaphragm to the selected point. When doing this the plane of sharpest focus should generally be slightly back from the nearest point of the subject—about one-third the distance from the nearest part to the most distant part of the subject appearing in the picture.

(3) Movement of the Camera: Camera vibration during exposure can be eliminated by employing a sturdy camera support to which the camera can be firmly fastened. Relative movement between lens and film, because of poor camera construction, can also cause poor definition.

(4) Movement of the Subject: On most occasions, movement of the subject during an exposure of one-half to one second can be eliminated by giving consideration to the comfort of the patient and providing mechanical means of immobilization. In some instances, however, the condition of the patient is such that a much shorter exposure time is imperative, most effectively obtained by the use of flash lamps.

(5) Negative Quality: Maximum definition in a print can be expected only if the negative is properly exposed and processed. Chemical and light fog greatly reduce the clarity of fine detail.

(6) The Printing Process: If the photographic print is made by contact, faulty design or operation of the printer may lead to poor definition. The platen or pressure plate of the printer should hold the negative and photographic paper in intimate contact throughout their entire area.

If the photographic print is made by projection, poor rendition of detail may be the fault of the lens, especially if a camera lens is used for this purpose. Some camera lenses are not suitable for enlarging because their optical design has been worked out to correct lens "faults" at greater distances than are employed in enlarging. At the shorter distances these corrections are no longer fully effective and poor definition results.

Poor definition may also arise from inaccurate focusing of the enlarger. Some enlargers are of the auto-focus type and it might seem that it is not necessary to pay any attention to this point. However, it is advisable to check up and make sure that the negative is accurately focused throughout the entire magnification range and that the paper board is being used at the proper level.

With other types of enlargers it is advisable to employ an easel focusing device.

For maximum brilliance of fine details in the photographic print, the negative in the carrier should be masked down to the area being printed.

Perspective.—A false impression of the extent of a lesion is sometimes given by a photograph because it was made from a point too near the subject. This occurs commonly when portrait attachments or supplementary lenses are used on roll film camera lenses in order to fill the negative area with an image of the desired portion of the subject. The effect is most noticeable in close-ups of lesions on the legs, arms, face, and other parts of the body with high curvature.

A certain amount of distortion of this type is present in every photograph of a curved surface. However, it is negligible

for ordinary purposes if the lens is far enough away. In photographs of surface lesions on the legs, arms, or the face a minimum working of 18 to 24 inches is usually satisfactory. With many cameras this will mean that the desired image size will have to be obtained by enlargement in printing.

Rendition of Color Differences.—In many medical subjects color differences are the most important features. Their effective rendition in monochrome is dependent upon three major factors—selection of film, choice of filter, and type of lighting.

The color contrasts in medical subjects usually consist of differences in reddishness. Where the contrast is great, as in surgical subjects and some gross specimens, a panchromatic film employed without a filter is most effective.

In some instances, however, the color differences are slight and it is desirable to accentuate them. This is most effectively accomplished by using an orthochromatic film or a panchromatic film with a green filter.

The method of lighting is also important in rendering color contrasts. In cases in which color differences are the important features of the subject, a relatively uniform, flat lighting is usually best.

Rendition of Texture.—Texture is a distinguishing feature of many medical subjects and in cases in which it must be recorded every precaution should be taken to secure maximum definition.

Proper lighting also is very important. A good general procedure is to place one light near the camera and locate another so that a line between it and the area being photographed is almost at right-angles to the camera axis. The light at the side will bring the surface texture of the subject into sharp relief and the light near the camera will illuminate the heavy cast shadows.

Print Quality.—Finally, we come to the photographic print itself. Unless definitely specified to the contrary, all prints submitted for publication should be made on glossy paper. Everything should be done to make the print as nearly mechanically perfect as possible—it should be dried so that it lies flat (ferrotyping is advisable), and dust marks and blemishes should be carefully "spotted."

It is frequently claimed that a print intended for reproduction should be more contrasty than one ordinarily considered ideal for viewing. In some cases this may be true, but in general a print which looks right will reproduce satisfactorily.

PART II.—FROM THE PHOTO-ENGRAVER

By FLOYD R. LEAR, *Easton, Pennsylvania*

Photo-engraving is an art of reproduction. Excellence is reached when a perfect reproduction of the original copy is achieved. Since photography is the basis of photo-engraving, the copy used for the purpose of illustration is most important.

The illustrations used in RADIOLOGY are printed from photo-engravings that come under two classifications—line engravings made from charts, graphs, and pen-and-ink drawings, and halftones made from photographs and x-ray photoprints, etc. The copy for both line cuts and halftones may be enlarged to about double the size of the copy and may be reduced to one-sixth the original size of the copy. However, extreme reductions usually lose much of the detail, while enlargements magnify any imperfections there may be in the original.

The copy for line cuts must have dense black lines on white stock and the detail must be sufficiently clear so that it will not be lost when reductions are made. If charts or graphs are photographed, the photographic print, used by the engraver as copy, should be made so that all lines are a dense black, even though the white back-

ground be slightly clouded. This is preferable to having a clear white background and gray lines.

If the above suggestions for line cuts are followed, the engraver will have no difficulty in the reproduction of clear and readable charts and graphs.

Halftones are made by photographing the copy through a screen which breaks the continued tones of the photographs into dots of various sizes which can readily be seen by looking at a halftone with a magnifying glass. Breaking the tones into dot formation causes the loss of some detail, which is noticeable even when the copy is reproduced same size. Therefore, wherever possible, unnecessary parts of the copy should be eliminated so that the essential part of the photograph will not require greater reduction than is absolutely necessary.

There are three classifications of dot formations which are found on every halftone engraving, namely, the high-light dot which is the lightest tone of the copy; the middle tones which include the light and darker grays, and the shadow dot which is the blacker tones. (You will notice by looking at any halftone reproduction the different size of dots in the various tones.)

To make a satisfactory etching of a halftone it is etched in the following steps: The plate is given a flat etch to a printing depth. The shadows are then held back by being painted in with an acid resist and the etching continues, giving a tone separation between the shadows and middle tones. After the middle tones have been sufficiently lightened these tones are held back and the high-lights etched lighter. By this separation various tones can be brought out by re-etching.

The reproduction of RADIOLOGY copy presents a problem to the engraver, when he is asked to faithfully reproduce photographic prints made from x-ray films, because he is unable to interpret the meaning of the x-rays and has no knowledge of details or what part of the copy is essential. Because of this he is sometimes at a loss to determine just what separation of tones should be made to bring out the desired detail and, therefore, reproduces the copy as he sees it from the layman's eye.

Various tones can be brought out by re-etching: some densities increase; some faint shading brought out more prominently; some tones lightened. In reproducing average copy the engraver has an opportunity to use his artistic judgment, but this is difficult in the reproduction of copy for RADIOLOGY. The copy is marked in numerous cases so that the engraver knows which details are essential, so that he can, by careful re-etching, bring out more clearly a halftone reproduction that interprets the x-ray photoprint correctly.

PART III.—FROM THE EDITOR

By LEON J. MENVILLE, M.D., *New Orleans, Louisiana*

The Editor is, in the manner of speaking, the middle man in the matter of illustrations. To him falls the task of taking the copy furnished him—often imperfect—and from it producing cuts for the published work, with the co-operation of the photo-engraver. His is a work largely of selection, which sometimes means sending back to the author for better copy. A few hints as to why he does this may not be amiss.

Charts and Diagrams.—The lettering and drawing should be on the same scale. For instance, if the drawing is large enough to be reduced to a single-column cut, and yet the lettering is so small that, when reduced, it will not be readable, something is manifestly wrong. It is often necessary to make the whole cut larger than its importance warrants, so that the reader may be able to read what it is all about. In pre-

paring your charts and diagrams, therefore, let the whole be drawn on a scale which will permit of uniform reduction, and yet be clearly readable. In that way you can put across to your readers your purpose in including the chart or diagram. Blueprints will not reproduce. Drawings on white paper or tracing cloth, in black India ink, are best for reproduction.

Grouping.—Unless illustrations must follow one another in a fixed order, if the author will place all his photomicrographs together, all his photographs of lesions or patients together, all his roentgenograms together, and so on, it is often possible for like to be paired off with like, reducing the total number of cuts to be made. This is not so easy to do if references to the cuts follow one another throughout the paper, though, even here, there is no objection to figure references occurring out of numerical order, if the cuts themselves are numbered consecutively from Figure 1 throughout.

Trimming.—This is done by the author or in the editorial office, and, more often than not, consists in ruling off unnecessary parts of the print. If a skin lesion is to be shown, it is not essential to send what is virtually a portrait of the patient. A small surrounding area will serve to indicate the anatomical part, and the less included, the larger will be the finished cut of the lesion under discussion.

Masking Likenesses of Patients.—In cases in which a patient's or technician's recognizable likeness is photographed, it is safe to mask the eyes so that he or she may not be identified. If to do this would hide a part of the lesion which it is desired to show, as, for example, edema about the eyes, then a signed statement should be secured from the patient (or his next of kin) granting permission to publish the photograph in a medical journal. This is a safe course to pursue, even though the individual be a personal friend. Masking the eyes is done by blotting out the eyes with a pen and ink or by pasting a bit of paper across them.

Mounting of Copy.—Copy may be mounted or not, at the will of the author. If mounted, the boards should not be larger than are essential, and of light weight.

What Not to Send.—Films, unaccompanied by prints from the same, should never be sent, nor should slides. Home-made drawings—unless one is oneself a skilled artist or can command the services of one—should not be sent in illustration. It is a matter of minor expense to have one's rough sketch copied by a draftsman or clinical artist—every man to his trade.

If possible, original drawings and charts should be sent with which to illustrate papers, instead of photographic copies of the originals.

Lettering of Photomicrographs.—This is a matter which can greatly enhance the value of photomicrographs of sections of tissue. Letter the cells plainly and largely, adding to the caption the letter and corresponding name of the cell. In this way the illustration will have value from the moment the reader glances at it; otherwise, its value will depend upon the amount of time the reader spends in reading through your text for your description of the particular cells in that particular figure. You, who understand well the significance of each cell in the section shown, can so easily letter them, *A*, *B*, etc., and thus increase their interest and value to your readers. Please remember to do the lettering on the face of the photograph with India ink which reproduces well.

Sharpness of Roentgenograms.—Send sharp, clear roentgenograms if you expect cuts of that character—and, make no mistake, the Author and the Editor *do want* such cuts. It goes without saying, that no roentgenograms should be retouched *unless it is plainly so stated in the caption.* There are occasions when it is permissible to emphasize given lines in that manner.

Conclusion.—Do not feel that you can send indifferent roentgenograms as illustrations, and that, in some way which you do not understand and concerning which you think it as well not to inquire, perfect cuts can be produced. The photo-engraver can do no more with his modalities than you can with yours.

PULMONARY CYSTS[1]

By A. R. SHIRLEY, M.D., Medical Officer in Roentgenology, Veterans Administration Facility, *Wood (Milwaukee), Wisconsin*

BEFORE presenting this unusual and interesting case of pulmonary cysts, I would like to make a few preliminary remarks. A diagnosis of liver abscess was made in 1929. A retrograde pyelogram of the right kidney made in September, 1936, revealed an anomalous bifid renal pelvis and a moderately enlarged kidney. A roentgenographic examination, in September, 1936 (Figs. 5 and 6) revealed an enlarged liver having a smooth lower border and fairly well filling up the entire right abdomen. Its enlargement also pushed the gas-containing loops of intestines well over into the left half of the abdomen. Of what did the enlargement consist? Was it carcinoma, hydatid cyst, or some other form of neoplasm? Unfortunately, an autopsy was not available.

The subject in question will be treated mainly from a roentgenologic standpoint. There is no question about the existence of cysts. The thing to be determined is, how do these cysts take origin and what appearance do they present roentgenologically at their inception? Unfortunately, the latter question cannot be answered because the cysts were not seen at their earliest stage. Obviously, a cyst which contains fluid, as ordinarily it will at its inception, would present itself on the roentgenograph as a circular or oval, smoothly outlined area of marked homogeneous density. An air-containing cyst would present a sharply defined circular or oval-shaped linear density confining within itself an area of radiability or translucency. An intermediate stage would present itself in a manner highly suggestive of that occasioned by a pulmonary abscess in which there is a fluid level. That is, the lower portion of the cyst would be dense and the upper, air-containing portion, markedly rarefied or translucent. Do all cysts at their inception contain fluid? The majority opinion is that they do. I believe, however, there is a fair agreement of opinion that the congenital type of cyst may present itself as an air-containing proposition or a fluid-containing —usually the latter. During the process of early development of the pulmonary tissue, the cystic portions may have remained in contact with an open bronchus, thereby resulting in an air-containing cyst, or they may have developed from, and later become independent of, the contributing bronchus, thereby resulting in a fluid-containing cyst. With regard to the hydatid cyst, it will first manifest itself as a rounded area of marked homogeneous density until such time as suppuration has set in. After perforation of a bronchus has resulted, an air communication is established between these structures. It is at this time that the roentgenologist would be puzzled in differentiating between a pulmonary abscess cavity containing fluid and a cyst. There does not appear to be much chance of confusion between a dermoid cyst and the other two types. The former always presents itself within the mediastinum and the latter usually within the lung parenchyma. It is clear to be seen that a fluid-containing pulmonary cyst could easily be confused with other pathological lesions.

I have in mind other types of neoplasm, sharply defined areas of pneumonic consolidation, localized empyema, localized atelectasis, and localized interlobar pleuritic thickening with effusion. It is to be remembered that any secondary infection of a cyst will modify to a greater or lesser degree the character of shadows immediately surrounding it. In this connection,

[1] Published with the permission of the Medical Director of the Veterans Administration, who assumes no responsibility for the opinions expressed or the conclusions drawn by the writer.

one thinks of the effect produced by the perforation of a fluid-containing cyst into the pleural cavity, thereby setting up a pyopneumothorax.

sharply outlined densities at the inner third of the right base. Seemingly, these had not been observed at that time or may not have been thought of particular sig-

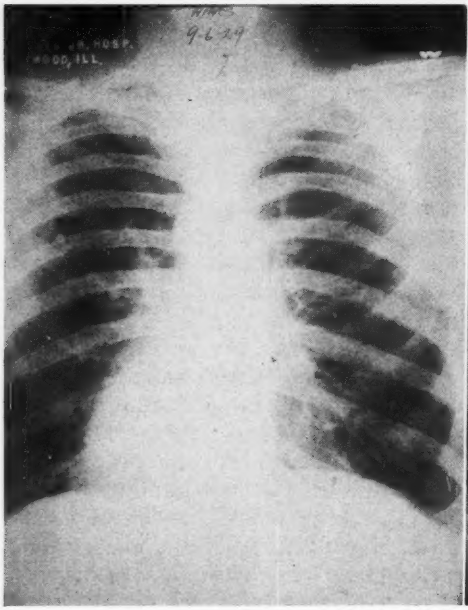

Fig. 1. Film made Sept. 6, 1929.

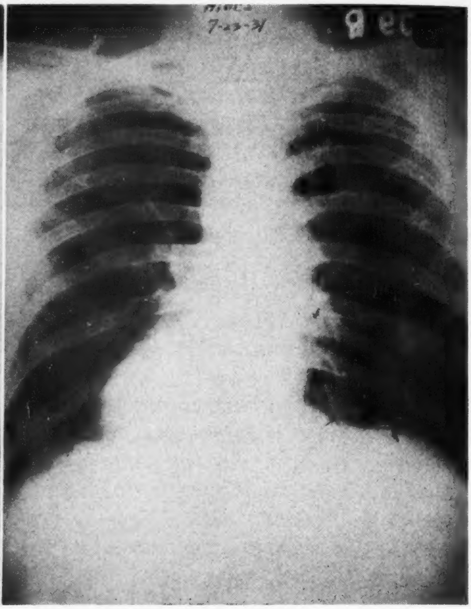

Fig. 2. Film made July 23, 1931.

There are, however, definite indications that would justify a diagnosis of cyst from the roentgenological standpoint, and these I have already related. Are the cysts that we are about to observe congenital or are they the result of an echinococcus infection? That is a point I feel we cannot definitely settle in this particular case. Unfortunately, an autopsy was not performed, and again unfortunately, the earlier manifestations of the cysts were not observed at the time of the first hospitalization of the patient. Had they been, perhaps a more thorough observation would have been made in the endeavor to fathom the causative factor. May I be pardoned if I go a little bit into minute detail in describing the findings recorded on the roentgenographs presented in this paper.

In the first one, taken on Sept. 6, 1929 (Fig. 1), you will note two semicircular,

nificance. In this connection, as later roentgenographs will show, we see the importance of describing every shadow presented in a film which, by its nature, is out of the ordinary. Stereoscopically, densities which look much like those produced by localized pleuritic thickening, are observed not to lie adjacent to the anterior or posterior chest wall, but within the lung tissue itself. These findings, therefore, indicate some abnormal condition within the lung parenchyma, highly suggestive of cystic formation. Insufficient air, however, is present within the confines of these linear densities to warrant a positive diagnosis of cyst, and certainly there is no contained increase of density to indicate the earliest formation of a fluid-containing cyst. The sharpness, however, of these linear densities is highly characteristic of a cystic wall.

A second roentgenographic examination, dated July 23, 1931 (Fig. 2), brings out an interesting phase. Note the sharpness of the linear convex densities and their expansion outward. These densities can be differentiated one from the other to a still better degree and within their confines one observes a condition of translucency or increased radiability. We have here the definite characteristics of cystic formation. Their character would have been determined better had a lateral and oblique view also been made at this time. As yet, one gets no idea of any definite communication between the cyst and the liver. Nothing in the way of a fistulous communication is noted. There is no definite diaphragmatic adhesion or other evidence of pleuritic thickening at the base. Why is this affair enlarging? The shadow is certainly not that of a malignant neoplasm, such as carcinoma. In such an event we would have an area of increased density, and not increased rarefaction. Evidently air is getting into this region to a greater degree than it is leaving it. Apparently there is a valve-like action at the point of communication between the cysts and the adjoining bronchi. There is an ever-increasing intra-cystic air pressure. We are dealing with balloon cysts.

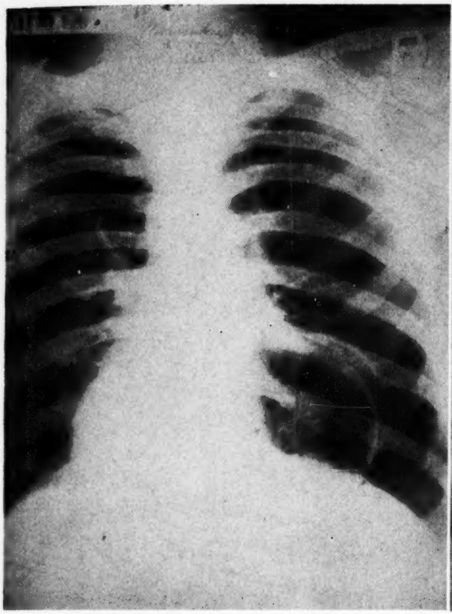

Fig. 3. Film made Oct. 2, 1933.

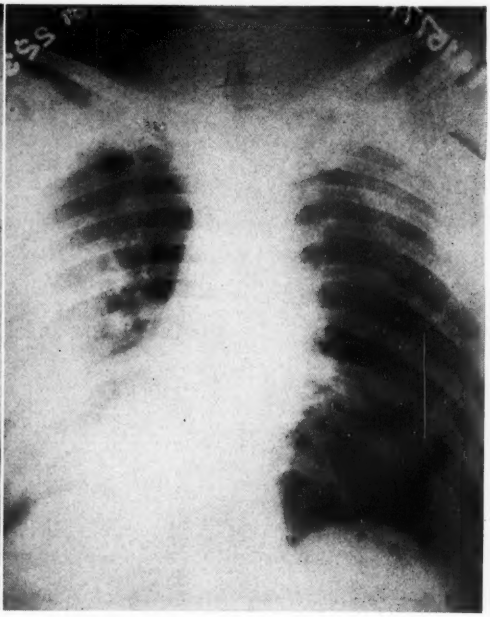

Fig. 4. Film made March 22, 1935.

A third and later roentgenographic examination, dated Oct. 2, 1933 (Fig. 3), a little over two years later, shows further enlargement of the cysts, with still further differentiation between the convex linear markings representing their peripheries. There is a further increase in the contained radiability. At this time one gets the impression of a connection between the cyst and a minute adhesion at the middle third of the right dome of the diaphragm.

A fourth examination, made March 22, 1935 (Fig. 4), shows further enlargement of the pulmonary cysts under consideration. One notes that the periphery of the outer cyst reaches out almost to the periph-

ery of the lateral chest wall. A practically unbroken shadow is observed within this larger cyst. Within the latter is noted particularly a spreading, as it were of the bronchial markings, with a diminution in their number. At the upper limit of the inner shadow one sees many well dilated bronchi and bronchioles. There appears to be no question of a direct communication between the cysts and the bronchi, and we have in this case a check-valve operation, permitting more air to enter the cysts than leaves. At this stage, note the rather definite exudative process within the lower two-thirds of the left lung. We have here obviously a pneumonic affair. Does this bear any relationship to the findings within the opposite lung or is it incidental? We have nothing as yet to indicate any direct communication of something that might have been going on in the liver and the pulmonic field. It will be noted that at no time have we observed a fluid level within the cysts. It would seem this might have been the case had we been dealing with an echinococcic affair.

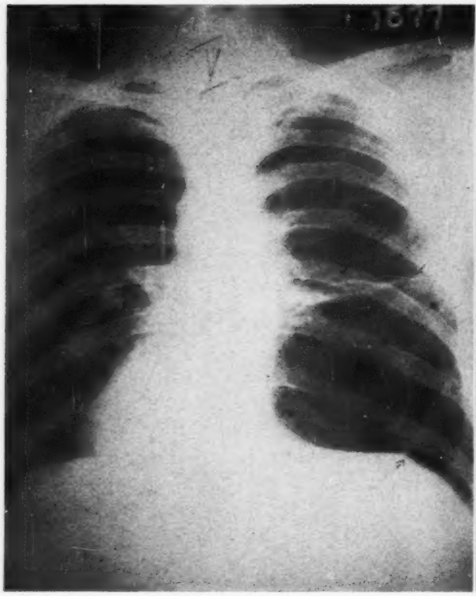

Fig. 5. Film made Sept. 1, 1936.

Fig. 6. Film made Sept. 9, 1936.

The fifth roentgenographic observation, dated Sept. 1, 1936 (Fig. 5), shows the left lung practically cleared up. There are no definite residuals of the pneumonic process, which was observed in the last previous examination. Note the minute diaphragmatic adhesion at the right base. Immediately above the cysts one sees something new; that is, evidence of an interlobar pleuritic thickening with accompanying strands of fibrous tissue. The natural question is, why is this? Perhaps there has been an infection of one of the smaller cysts which lies adjacent to the larger and major ones, and we now have the residuals of a pneumonic process or interlobar pleurisy with effusion. I believe it would be the consensus of opinion that, had there been an extension of some cystic formation lying within the liver other than through the blood stream, we would have had more evidence of such at the right base, possibly in the way of

further adhesions and pleuritic thickening. So far, but one adhesion has stood out. Note the slight flattening of the inner half of the right dome of the diaphragm, apparently due to the intracystic air pressure immediately above it.

In order to bring out further data concerning the conformation and location of the cysts, lateral and oblique views of the chest were made. These, dated Sept. 9, 1936, bring clearly into view the two major cysts. Note again their sharply defined walls. The larger lies within the anterior half of the lower right chest and the smaller within the posterior half. Observe also the well-defined bronchial divisions at the upper limits of the cysts, seeming to be in direct communication with them. The distal end of the trachea is clearly defined and one gets the impression of some slight constriction, possibly as the result of contraction of the surrounding fibrous tissue. Roentgenographs herewith presented, in the order submitted, one to six, show unusually well the development and progress of the balloon type of cyst. I believe there would be a uniformity of opinion that in this case—

(*A*) Dermoid cyst impossible. It is always in the mediastinum.

(*B*) Echinococcus cyst possible. More data, especially clinical, necessary.

(*C*) Acquired cyst from some localized bronchial pathology possible.

(*D*) Congenital cyst probable.

Had the cysts been of echinococcic origin, it would seem we would have observed somewhere within the series some retraction of the cyst wall and cicatricial replacement after expulsion of the cystic membrane. There has been no indication of such and certainly no indication of rupture of any cyst in the liver, if such had been present, into the thoracic cavity. In this connection it is stated that only about 11 per cent of liver hydatid cysts rupture into the thoracic cavity. It would seem also that had the cysts been echinococcic in origin we would have seen some indication of fluid content within the cysts during this man's illness; again, had they been hydatid in character, there would have been some retraction of the cystic wall and scar tissue replacement.

INTESTINAL OBSTRUCTION[1]

By N. S. ZEITLIN, M.D., *Chicago, Illinois*

From the Edgewater Hospital

ALTHOUGH considerable literature has accumulated on the diagnosis and treatment of intestinal obstruction, the mortality rate, at least for acute obstruction, remains practically what it was a decade ago.

If the clinician will persist in waiting for obstipation and fecal vomiting, he will raise the mortality rate from 5 per cent for early cases, to over 50 per cent for advanced cases. The clinician would do well to come to the roentgenologist for help before the diagnosis is obvious. We feel that the roentgenologist may assume considerable responsibility, even in the very early cases.

Since the work of Schwartz, in 1911, and Case, in 1914, we have been convinced that gas in the small bowel means stasis. Why, then, has not the roentgenologist solved the problem of the late diagnosis and the resultant high mortality?

Although my study includes only 100 cases, I feel the reasons are clear. First, a significant number of clinicians are still not fully aware of the value of flat films of the abdomen in intestinal obstruction; second, the clinician frequently is fooled by the passage of small amounts of gas and feces, and third, some practice and considerable patience are necessary before one can become adept in recognizing the early partial obstruction in the flat film of the abdomen.

Diagnosis.—The diagnosis of intestinal obstruction by means of flat films of the abdomen, rests entirely upon the recognition of large amounts of gas in the small bowel, or the lack of continuity of the gas column in the large bowel. Thus, it becomes entirely a question of differentiating the small from the large bowel. At first thought, this may seem very simple, and, in the usual case of dynamic small-bowel obstruction, the problem is relatively easy. Frequently, however, the films are extremely difficult to interpret. In such cases, one must make multiple exposures in prone, supine, and even lateral positions, and patiently study each collection of gas for the characteristic appearance of the small bowel. When there are the typical "stepladder" layers of small bowel, it is not necessary to be a roentgenologist to make the diagnosis. But, if we are to be true specialists, we must be able to recognize the very early case, when the distention is only slight. In common with other authors, the writer has found the demonstration of Kerkring folds to be absolutely pathognomonic of the small bowel. However, these fine folds are not always visualized satisfactorily. In reviewing all my films, I have come to the conclusion that the difficulties were nearly always due to poor films. It is believed, therefore, that the technically good film is the secret of successful diagnosis. This point cannot be stressed too much. Roentgenologists demand the sharpest exposures in chest films, and yet they are frequently satisfied with poor films of the abdomen, forgetting that the Kerkring folds of the small bowel are as delicate as the fine bronchial markings of the chest. The least movement during exposure, or a slight over-exposure, is sufficient to make it difficult or even impossible to render a diagnosis.

Unfortunately, good films are not always possible. Frequently the patient is too sick to co-operate. At times only portable long-time exposures are available. This difficulty has been partially overcome by the use of the Lysholm grid; but, as a rule, the radiologist demands that the patient be moved to the x-ray department for fast exposures.

Even in the absence of full Kerkring folds, certain secondary features are indicative of small-bowel distention. Thus, a

[1] Presented before the Fifth International Congress of Radiology, at Chicago, Sept. 13–17, 1937.

Fig. 1.

Fig. 2.

Fig. 1. Case 1. Gall-bladder examination. No concentration of the dye. The significance of the gas shadow was missed.

Fig. 2. Case 2. Carcinoma of the sigmoid; distended colon; very little gas in the ileum. Gas column stops at the sigmoid.

collection of gas near the mid-line in the supine position should always be considered with suspicion. The appearance of such an isolated loop of small bowel will depend entirely upon its position relative to the x-ray beam; thus, there may be only a short loop three or four inches long, with perfectly smooth border on one side and a few fine serrations on the other. Again, the loop may present itself on edge and reveal the appearance of a trabeculated cavity. Here we see a cluster of black oval or round shadows, traversed by thin bands, and resembling a trabeculated congenital cyst of the lung. The serrations of Kerkring folds can usually be differentiated from the haustral markings of the colon: the latter are coarser, do not cut through the entire colon, are wider apart, and are associated with the characteristic central white knob.

Pitfalls.—At the beginning of this series, errors were made, which, it is believed, are now, for the most part, avoidable.

The type of case which has caused most trouble is that of an old individual with a redundant colon. Frequently, in such a case, the obstruction is low in the sigmoid, and the small-bowel distention is relatively slight. Thus, the only chance for an early diagnosis is to follow out the colon loops carefully, until all the gas is accounted for. As soon as a collection of gas is not accounted for, distention of the small bowel should be suspected, and further steps taken to verify the diagnosis. This can be done in practically every case by means of multiple films in prone and supine positions, and occasionally by the use of an incomplete barium enema reaching just beyond the visualized column of colon gas.

Another type of case which has presented considerable trouble is that with diminished colon gas. Often there is no demonstrable small-bowel distention in the first film, and one is inclined to call it negative for obstruction. But, if one will keep in mind that the colon normally contains appreciable amounts of gas, one will not be misled. In instances in which there is only a small amount of colon gas, a single film is not sufficient. Supine and prone films must be made and repeated, if necessary, in several hours. Frequently, one will find a single isolated loop of distended small bowel, sufficient to make a diagnosis of partial obstruction. Of course it must be remembered that repeated catharsis and cleansing enemas may remove most of the colon gas in a normal case; but the careful roentgenologist will do well to adhere to this

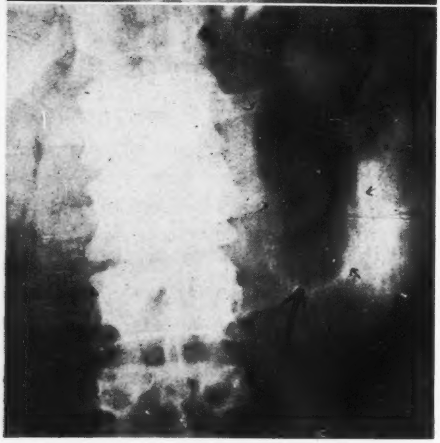

Fig. 3 (*upper*). Case 3. An isolated loop of distended small bowel which should have aroused suspicion. Operation was performed three days later, and the obstruction relieved.

rule, "A single film in a case of suspected intestinal obstruction, showing no gas in the small bowel, and only a small amount of gas in the colon does not rule out obstruction."

Still a third type of case which has caused concern, is that which presents the problem of partial reflex ileus. Gas in the small bowel, radiologists may all agree, is abnormal, but certainly it does not mean mechanical obstruction in every case.

Gas in the small bowel has frequently been associated with renal or gall-bladder colic; but often there was no demonstrable cause for the gas, and the questionable diagnosis of gastro-intestinal pneumatosis was resorted to. Aged, debilitated patients, particularly, showed these apparently innocent collections of small-bowel gas. In such cases, obstruction was ruled out by tracing large amounts of gas from the cecum to the rectum, and, secondly, by noting that the size of the small bowel was normal; in other words, there was no distention. Thus it has been concluded by the writer that for the diagnosis of obstruction, two characteristic features must be found, namely, the presence of gas and the presence of appreciable distention.

The use of cleansing enemas has frequently caused delay in the diagnosis. L. Ginzburg, in 1932, brought up the question of the effect of cleansing enemas upon the gas content of the large bowel. His experience led him to think that gas in the distal colon was expelled with the enema, and that retention of a portion of the enema led to the formation of false fluid levels. With this in mind, the author has many times considered a diagnosis of reflex ileus or peritonitis, in which the small bowel was distended and the proximal large bowel contained only a small amount of gas. It

Fig. 4 (*center*). Case 4. Post-operative roentgenogram. Patient treated by surgeon for many days for peritonitis with paralytic ileus. X-ray examination indicates mechanical obstruction. No gas in the colon. Secondary operation was performed and the obstruction relieved.

Fig. 5 (*lower*). Case 6. Prone position shows one distended loop of bowel. Operation was performed and adhesions were cut.

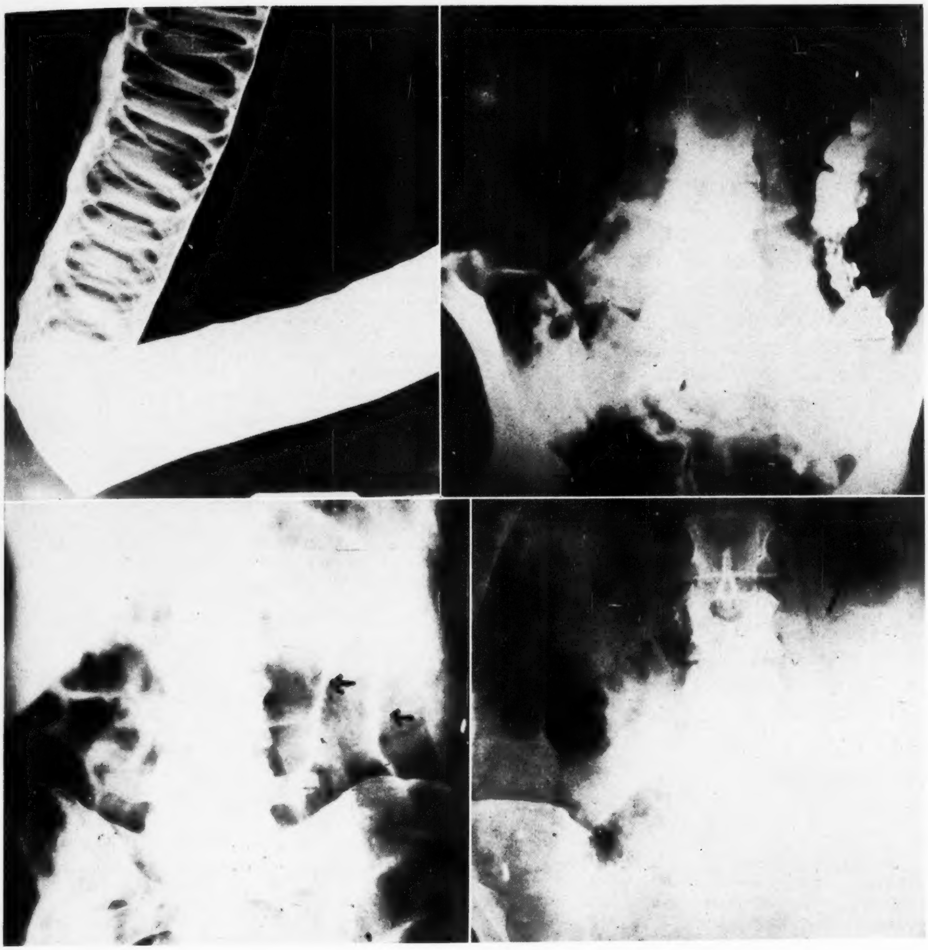

Fig. 6 (*upper left*). Case 7. Resected jejunum. Lower portion filled with water, obliterating the Kerkring folds. The upper portion filled with air alone shows the folds. This may explain the apparent lack of gas in some cases of obstruction.

Fig. 7 (*upper right*). Case 8. Prone position. Gas in small bowel resembling the colon. Partial barium enema shows gas outside the colon.

Fig. 8 (*lower left*). Case 9. Reflex ileus. Note gas but no relative distention of the small bowel. Large bowel is filled with gas. Supine position.

Fig. 9 (*lower right*). Case 10. Several small areas of small-bowel distention. Obstruction found at operation.

was feared that the colon gas had been removed by the cleansing enema, but, in all such cases, that was a mistake. The writer has come to the conclusion that a reflex or paralytic ileus, with the usually distended colon, loses but little of its colon gas with the cleansing enema, and that little only in the sigmoid and a portion of the descending colon: the transverse and ascending colons are hardly touched. Again we recall the important feature in these studies, and that is, that gas alone is not enough; distention must also be present. Thus, if the small bowel is distended, it means stasis and obstruction. If the colon, in the same case, shows a small amount of gas and no distention, we may feel assured that a partial mechanical obstruction exists, whether or not cleansing enemas have been given.

CONCLUSIONS

From experience, the following conclusions have been reached:

1. Technically good films with elimination of all movement are essential. Whenever possible, the patient should be moved to the x-ray table, and high milliamperage used to cut down the time to a fraction of a second. When this is impossible, the Lysholm grid should be used.

2. Multiple views in prone and supine positions are frequently necessary. A negative diagnosis based on a single film, in a case of suspected obstruction, may lead to error.

3. Gas in the small bowel is not sufficient to warrant a diagnosis of obstruction; distention is essential. The relative size of the colon and small bowel must always be remembered.

4. Frequently, the obstruction will manifest itself by a visualized distention of only one isolated loop of small bowel.

5. The passage of small amounts of stool material and gas does not rule out the diagnosis of intestinal obstruction.

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THE RELATION OF TISSUE RECOVERY AND THE HEALING PROCESS TO THE PERIODICITY OF RADIATION EFFECTS[1]

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IT has been indicated that the amount of recovery from radiation effects of tissues exposed to daily fractionated doses of radiation is a more or less constant factor for each day.

Reisner (1), and Quimby and MacComb (2, 3) have measured experimentally the daily potency of this recovery factor for skin up to a period of 30 days, and their figures more accurately represent the quantitative values of this recovery factor than any hitherto published. The quoted values of the recovery factor after approximately the first week have a somewhat diminished significance because, with increased protraction of fractionated doses of radiation, comes an increase in the variation of individual skin reactions.

After approximately the third week of daily treatments, new phenomena begin to manifest themselves and divide the period of treatment into two types of phases, the destructive phase and the healing phase. These phenomena seem to be governed by the healing process, a mechanism which appears to be distinct from the recovery process, described by Reisner, Quimby and MacComb.

DESTRUCTIVE PHASE

This study was conducted in the course of our routine treatment of neoplasms of the upper respiratory tract with protracted fractionated radiation under clinical experimental conditions of an approximately identical technic for all cases. We first determined the typical average epithelitis and epidermitis reactions to a standard technic. In Figure 1, for example, are recorded complete epithelitis reaction curves of patients receiving a total dose of from 8,000 to 8,160 r (measured with back-scattering) in from 24 to 29 days.

The destructive phase, as we have adduced from other facts to be shown later, occupies approximately the first four weeks of treatment. The healing phase occupies varying lengths of time thereafter, ranging from four to six weeks. It is strikingly evident in Figure 1 that the cellulicidal effects of the destructive phase are somewhat constant in their time of onset and ascent within a range of eight days, whereas the phenomena of the healing phase are subject to more marked individual variations, within a range of 19 days. Thus the smallest and largest reactions were produced by the same dose, *i.e.*, 8,160 r delivered in 25 days.

The first destructive phase, occupying approximately the first twenty-eight days of treatment, is the most important era in the entire plan of radiation treatment, because the rays are more effective and the tumor more radiosensitive than at any subsequent time. The cellulicidal effects predominate, and the success of the treatment depends upon the efficient utilization of this time. The reactions tend to be constant in character, providing the daily dose is large enough to produce severe ones. The potency of the autonomous force for destruction is so great as to eradicate any difference in biologic effect between the various wave lengths of radiation herein observed (Fig. 3).

In order to explore further these phases, the daily skin dose of 200 r (measured with back-scattering) to each of two portals was cut in half and protracted for an extended length of time up to three and one-half months. By this means it was felt that

[1] Presented before the American Association for Cancer Research, June, 1938. Also to be used as basis for part of Refresher Course, Radiological Society of North America, December, 1939.

any existent delicate biologic phenomena might not be obliterated by too intense a reaction. It was with this technic that we observed reactions which recurred cyclically. To this phenomenon of cyclic recurrence of reactions, we applied the term, *periodicity*.

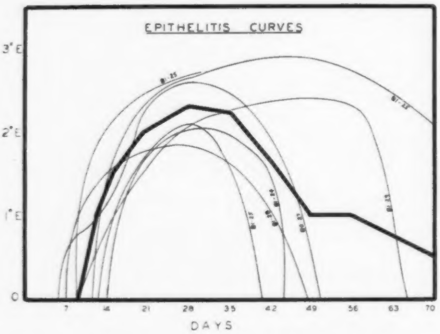

Fig. 1. Complete epithelitis curves of patients who have received a total dose of from 8,000 to 8,160 r in from 24 to 29 days. The factors were: 200 kv. x-rays filtered through 0.5 mm. copper and 1 mm. aluminum. The heavy line represents the average of the portrayed curves. Observe that during the destructive phase, lasting up to the twenty-eighth day during which time the treatments were being given, there is some degree of constancy of the reactions though they varied ±4 days from the average. This is one example of the tendency toward constancy of the destructive phenomena. Observe the enormous individual variations during the healing phase, after the twenty-eighth day, when no further treatments were being given. The smallest and the largest reaction curves were produced by the same dose, namely, 8,160 r in 25 days. This is an excellent example that individual susceptibility plays a highly important rôle in healing phenomena.

Figure 2 represents a patient with a radiosensitive carcinoma of the base of the tongue who received one-half our usual daily dose, namely, 100 r to each of two portals every day over a period of 81 days, for a total dose of 14,000 r (measured with scattering). It is observed that the reactions increased in intensity until the twenty-sixth day, and then commenced to heal while treatments were being given. On the fifty-third day, a second periodic cycle of reactions commenced.

Daily fractionated doses of x-rays are cumulative in their effect and the reactions become progressively more intense. However, each cellulicidal increment evokes a simultaneous, companion healing effect, and this too appears to be cumulative. The daily healing increment commences tardily and at a slower rate than the destructive process, but soon acquires a progressively increasing momentum until it is converted from a potential to a kinetic energy, and finally overwhelms and neutralizes the destructive effect, thus initiating the healing phase. During the healing phase, the reactions heal while treatments are being given. This is observed either when a low daily dose is used, or when the patient is hypo-susceptible.

This interpolation of a healing process which is tardy in onset but which accelerates as it progresses, is not necessarily irreconcilable with Reisner's, and Quimby and MacComb's demonstration of a recovery factor the magnitude of which is greatest on the first day and which becomes progressively smaller until it attains a stationary level. It is possible that there are two separate entities. Reisner's, and Quimby and MacComb's recovery factor is greatest on the first day because it is unopposed by any residual destructive effect of a previous treatment. On the succeeding days, the recovery factor is of lesser magnitude because it is opposed by the cumulatively increasing force of the repeated destructive doses.

This early recovery phenomenon appears to be a passive, recuperative one, occurring as a function of the size of the radiation dose itself, whereas the healing process herein described by us is less a recuperative or recovery one, and more a true active healing process, having a latent effect, and being accompanied by definite histologic changes of maturation of incompletely developed cells, and renewed growth activity of residual epithelial cells. (These histologic changes, observed by means of multiple biopsies taken during the course of treatment, will be described in a future publication. Melnick (7) has described them in animal tumors.)

The average healing phase is observed to commence between the thirty-fifth and forty-second day and lasts about four

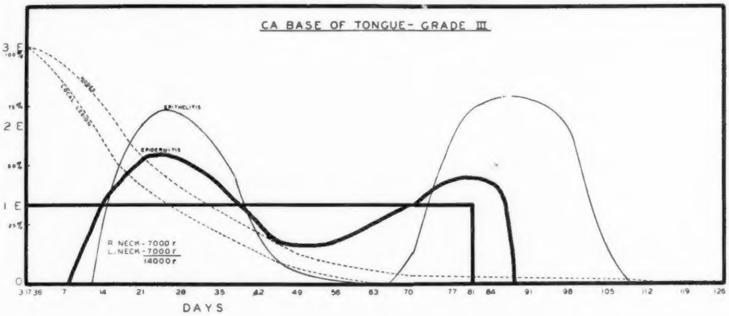

Fig. 2. Reaction curves of a histologic Grade III carcinoma of the dorsum of the base of the tongue treated with one-half the usual daily dose, namely, 100 r (measured with back-scattering) to each of two lateral neck portals. The factors were: 200 kv., 6 ma., 50 cm. distance, 10 × 15 cm. portal, 0.5 mm. copper, and 2 mm. aluminum filter; dosage rate, 12 r/min. The patient received a total dose of 14,000 r over a period of 81 days. The first destructive phase was rather short, lasting 26 days, the first healing phase extending from the twenty-sixth day to the fifty-fourth day, after which time the second cycle of reactions appeared. During this healing phase, the epithelitis and epidermitis healed while the treatments were being given. The second healing phase was followed by a second cycle of phases commencing with the destructive phase. It is this alternation of destructive and healing phases which we term *periodicity*.

weeks, until the healing processes have expended their energy and a new destructive phase ensues.

The destructive phase commences with the onset of the treatment and terminates at the peak of the reactions. It is dependent upon:

(1) Quality of the radiation
(2) Size of the dose
(3) Individual susceptibility
(4) Daily exposure time and dosage rate
(5) Continuity of treatment.

1. *The Quality of the Radiation.*—In Figure 3 are observed the average onset of epithelitis and epidermitis curves occurring during the destructive phase of patients treated with 200 kv. x-rays filtered with 0.5 and 2 mm. copper, and with the 5-gram radium pack. These averages are taken from the curves of patients who were treated exactly alike and had missed no treatments except on Sundays. The patients exposed to x-rays received 200 r (measured with scattering) daily to each of two lateral neck portals. The gamma-ray-treated patients received 5,000 mg.-hr. daily to one of two alternate neck portals at 6 cm. distance. The thin lines represent the x-ray reactions which, because of the close similarity of the technics, permit the deduction of fairly accurate conclusions.

It is observed that the shorter wave length x-rays produce reactions which appear somewhat later and are somewhat less intense than the longer wave-length x-rays, the energy of which is more readily absorbed and converted into biologic effects.

The similarly produced gamma-ray reaction curves (represented in Figure 3 by the heavy lines) were compared with the x-ray curves. Based upon our experiences with subintensive doses such as skin erythema tests, one would expect the gamma-ray reactions to appear later than the x-ray reactions. Instead, they appear at approximately the same time as the x-ray-reaction curves. Thus, ray quality effects are nullified by the size of the dose (see below) if the daily dose is large enough to produce intense reactions.

2. *Size of the Dose.*—When the daily dose is large and the reactions are intense, as occurs within the therapeutic range, the more constant are the reactions and the greater is their tendency to follow a single pattern, dictated by the destructive effects.

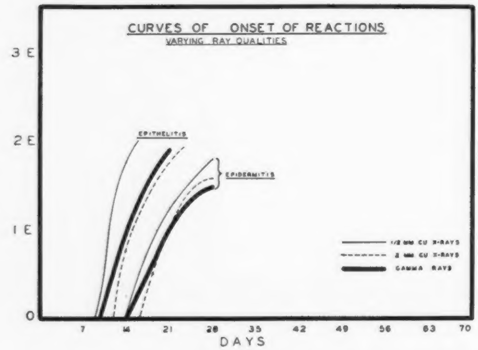

Fig. 3.

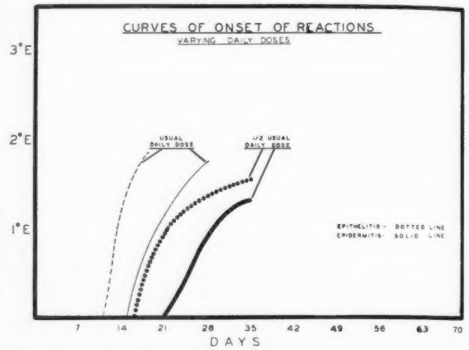

Fig. 4.

Fig. 3. Average curves showing influence of wave length on onset of reactions. The above lines represent the average curves of onset of reactions of those patients who regularly received six daily treatments a week, skipping only Sundays, up to the seventeenth day. Thereafter patients began to miss occasional treatments. Permitting a lapse of about seven days for latent effect, it can be assumed that up to the twenty-fourth day the above curves portray an accurate representation of the average type of reaction. The thin, solid lines represent the reactions of 0.5 mm. copper-filtered x-rays; the thin, dotted lines, of 2 mm. copper-filtered x-rays, and the heavy, solid lines, gamma rays. When x-rays alone are compared, it is found that the harder rays are somewhat less biologically effective and appear at a somewhat later date. However, when the gamma rays are taken into consideration, it is seen that destructive phenomena, if they are severe enough, tend to produce a constant type of reaction regardless of wave length.

Fig. 4. Average curves showing influence of size of daily dose on onset of reactions. The thin, dotted line represents the average of the three epithelitis curves taken from Figure 3. The thin, solid line represents the average of the three epidermitis curves taken from Figure 3. The heavy, dotted and solid lines represent the average epithelitis and epidermitis of those patients who received one-half of our usual daily dose, namely, 100 r to each of two lateral neck portals, or else 2,500 mg.-hr. with a 5-gram radium pack to only one neck portal a day. It can be observed that the smaller the daily dose, the tardier and the milder are the reactions. This is probably due to the fact that the smaller daily dose permits the healing process to exercise increased influence. Furthermore, the smaller the daily dose, the greater is the individual variation because with one-half the usual daily dose the day of onset of reaction ranged ±9 days on either side of the average curve, as compared with ±4 days when the usual daily dose was given (Fig. 1).

When the dose is small, as occurs in the technic of administering one-half our usual daily dose, the reactions are mild and heal early.

In Figure 4, the thin dotted line represents the average of the three epithleitis curves seen in Figure 3, and the thin solid line, the average of the three epidermitis curves. These were produced by our routine therapeutic doses as stated above. The heavy lines in Figure 4 represent the average curves produced by one-half the above routine daily dose. This smaller daily dose was employed experimentally in order to observe differential effects and to avoid the conformity of reactions produced by the large destructive doses in the therapeutic range. It is thus seen that the smaller the daily dose, the later is the onset of the reactions, and the lesser is their severity. Furthermore, when the destructive effects are mild, the individual variation is much greater than when the destructive effects are severe. Thus, in Figure 4, the day of onset of the epithelitis, with one-half the usual daily dose, ranged from the tenth to the twenty-eighth day, whereas in Figure 3, the day of onset of the epithelitis when the usual daily dose was employed ranged from only the sixth to the fourteenth day.

3. *Individual Susceptibility.*—A hypersensitive patient, though exposed to small daily doses, may have severe reactions which appear early, reach a third-degree intensity, and require months to heal. The

converse applies to hypo-susceptible patients.

4. *Daily Exposure Time and Dosage Rate.*—Early experimental and clinical evidence tended to suggest that the effect of a single dose was enhanced by extending it over a longer period of time. On this basis, Coutard (6) advocated a low dosage rate. Quimby and MacComb (3), however, have shown that a high dosage rate may be employed with equal effectiveness if one-half of the dose is administered at the beginning and the other half at the end of the time ordinarily allotted for the administration of a daily dose at a low dosage rate.

The effect of change in milliamperage on the dosage rate was studied by observing the skin reactions produced at different milliamperages. We find that there is a demonstrable though minimal difference in the skin erythema when the ratio in dosage rate is as low as 1 : 5 (*i.e.*, 200 k.v. x-rays at 4 ma., compared with 20 ma., wherein the exposure times are ten minutes and fifty minutes). When a single exposure is employed, a lower dosage rate produces a less intense biologic effect.

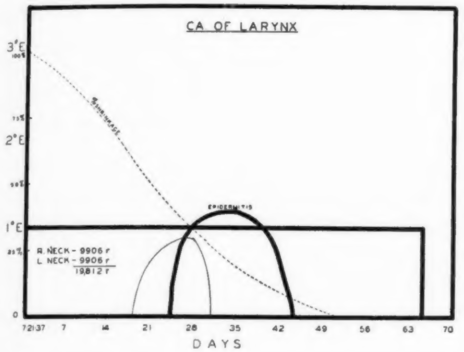

Fig. 5.

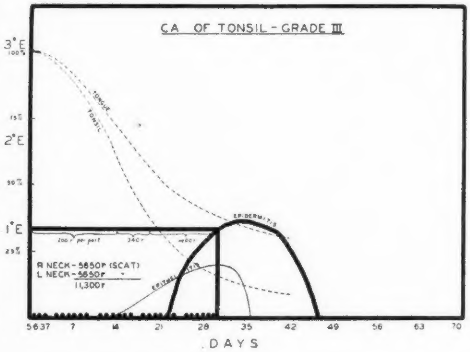

Fig. 6.

Fig. 5. Reaction curves of a case of carcinoma of the larynx. The factors were: 200 kv., 8 ma., 50 cm. distance, 8 × 10 cm. portal, 0.5 mm. copper, and 1 mm. aluminum filter; dosage rate, 400 r daily to one alternate neck portal. (This dosage rate produces the same reactions as our usual daily dose of 200 r to each of two lateral portals.) A total dose of 19,812 r (measured with back-scattering) was given over a period of 65 days. The patient had such a potent radio-immunization as well as healing process that he developed only first-degree reactions which also appeared tardily, and these healed rapidly while treatments were being given. This tolerance of his normal tissues for large doses of radiation was reflected in the tumor which recurred a few months later. We now recognize that it would have been a wiser procedure in this case to terminate the radiation after the fourth week and to wait a month or more for the healing process to expend its energy and then to resume with a second course of treatments.

Fig. 6. The application of knowledge of the healing process to the inverse pyramid technic. The chart portrays reaction curves of a case of carcinoma of the tonsil, histological Grade III—radiosensitive. This patient was first treated with the usual daily dose of 200 r per portal. It was early recognized that he had a strong healing process because of the tardy and mild reactions. The daily dose per portal was increased to 340 r and finally to 400 r so that a total dose of 11,300 r was administered in 30 days. In spite of this enormous dose, however, the reactions attained only a first-degree intensity. The tumor also exhibited this strong adaptation to radiation and failed to disappear completely as would ordinarily be expected of such a radiosensitive tumor. This inverse pyramid technic is feasible, providing that the early small doses are not so small that they have little cellulicidal effect and serve only to stimulate the healing process to increased activity. It is of interest to note that the portion of the tumor which extended into the tongue was more radioresistant than the tonsillar lesion itself.

When daily fractionated doses are employed up to four days, a dosage rate which is low enough to provide continuous uninterrupted irradiation is equally as effective as the high dosage rate given in intermittent daily doses, provided the total dose delivered in a given time is the same (Quimby). Therefore, when daily exposures up to four days are given, there is no clinical difference between a high and low dosage rate.

When the fractionation is carried on for

three weeks or more (Friedman and Rosh, 4)[2], the low dosage rate is 20 per cent more effective than the higher dosage rate (when the ratio of daily exposure is one hour *versus* twenty-four hours).

is given in two hours rather than in ten minutes. Kirchhoff and Kelbling (11) have even been able to demonstrate on rabbit testicles that, as far as radiosensitive tissue is concerned, there is no

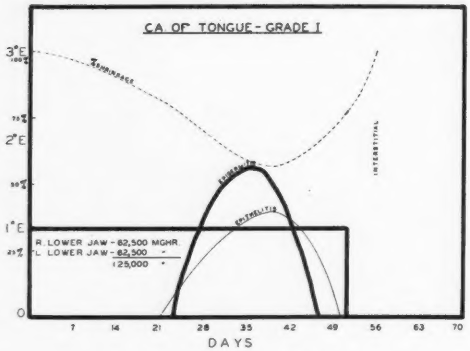

Fig. 7.

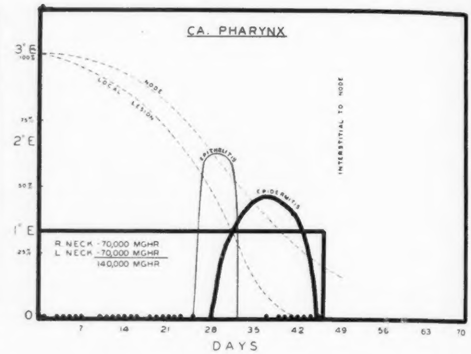

Fig. 8.

Fig. 7. Reaction curves of a case of squamous-cell epidermoid carcinoma of the tongue histologic Grade I—radioresistant. The patient received one-half the usual daily dose: 2,500 mg.-hr. daily to only one alternate neck portal given with the 5-gram radium pack. The healing phase commenced on the thirty-fifth day. During this phase not only did the skin and mucosa heal while radiation was being administered, but also the tumor became not only morphologically differentiated but also physiologically mature so as to exhibit the capacity to adapt itself to radiation and to proliferate in spite of continued radiation bombardment. A total dose of 125,000 mg.-hr. was administered in 51 days. (The average case routinely receives about 120,000 mg.-hr. in 28 days.)

Fig. 8. Reaction curves of a case of carcinoma of the pharynx to illustrate the effect of discontinuity of treatment. This patient was treated with a 5-gram pack and received the usual daily dose of 5,000 mg.-hr. to one alternate neck portal. After the twenty-fifth day, he voluntarily interrupted treatments for a period of 12 days because of the discomfort of the reactions. By the time he resumed the last part of his course of treatments, the healing phase had been reached and the healing process had become so potent by virtue of the rest period that the last few treatments were readily tolerated and had no effect on the course of reactions.

Thus with a single exposure, a low dosage rate is less effective than a high dosage rate. For exposures up to four days the effects are the same. When the daily exposures are extended beyond that time (up to three or four weeks), there is an inverse effect, wherein the low dosage rate becomes more effective than the high dosage rate.

It has still not yet been definitely proved that, if protracted fractionated radiation is employed in clinical therapeutic doses, better results are obtained when the dose

[2] This comparison was made between a 5-gram pack which gave 2,500 mg.-hr. in one hour, and a 100-mg. pack which gave 2,400 mg.-hr. in twenty-four hours. This is a clinical comparison which could not be as strictly controlled as the other experimental comparisons, and the conclusion drawn from it, though probably true, cannot, as yet, be indisputably maintained.

difference in the histologic changes between dosage rates of 2 r/min. and 75 r/min.

These facts suggest that, though the dosage rate can experimentally influence reactions in response to a small biologic dose such as a skin erythema dose, protracted fractionated doses, as employed clinically, produce such an overwhelming destructive effect as to wipe out these delicate differences. Only when the difference in exposure time is as high as one hour compared with twenty-four hours, and when the radiation is carried out for more than twenty-one days, can there be demonstrated clinically a difference in the biologic effect.

5. *The Continuity of the Treatment.*—The first three or four weeks of treatment are the most important in any plan of radiation, because the tumor is most radiosen-

sitive, and the healing forces have not yet attained a potency sufficient to increase the radioresistance of the tumor. Any interruption in the daily treatment during this time will retard and depress the desired epithelitis and epidermitis, and will unfavorably influence the prognosis in two ways: first, by extending the treatment course into the healing phase wherein the tumor has become more radioresistant, and, second, by permitting the healing forces, during the treatment-free period, to gain additional power and momentum.

HEALING PHASE

The healing phase is of much greater consequence than the destructive phase in the behavior of the tumor. Its limits are more difficult to define; its character is controlled by the strength of the specific healing process of the individual patient. Synonymous terms for the healing process are *recovery process* and *adaptation process* (Ewing's term, 5). The term, *recovery process*, is probably not truly synonymous because it seems to us to be a passive, recuperative phenomenon depending upon the size and frequency of the dose, and is a relatively simple phenomenon occurring during the first week or so of treatment. The forces of the *healing process* are, however, very complex. They are active, reactive phenomena, and are not exclusively dependent on the size and frequency of the dose, though they are modified by it. The terms, *adaptation process* and *healing process* more closely suggest the phenomenon we are discussing.

Some patients have a strong initial recovery factor which renders their skin and mucosa radio-immune, so that enormous doses of radiation will produce only very mild and tardy reactions which will not recur in spite of continued irradiation (Fig. 5).

The length of the healing phase is difficult to define: it commences at the peak of the reaction of the destructive phase and continues for varying intervals, depending upon the criterion used for its termination. This may be the time of onset of the second destructive phase, the point when the reactions finally heal, the time when the tumor ceases to regress, or the time when reparative fibrosis ceases to function actively. If the initial reaction is unusually severe because of either a large dose or a hypersusceptible patient, the destructive phenomena may extend into the healing phase. There is too great an individual variation to permit a more or less exact quantitative delineation of the healing phase. Essentially, however, we acknowledge the qualitative existence of such a phase and suggest the clinical application of the underlying principles.

The same factors which influence the destructive phase modify the healing phase but to different degrees.

1. *The Quality of the Radiation.*—As indicated earlier, the different biologic effects of varying ray qualities can be demonstrated with single doses under experimental conditions, but protracted fractionation of unit doses eradicates such delicate differential effects. By the time the healing phase is reached the importance of ray quality differential effects has become minimal.

2. *The Size of the Dose.*—The size of the daily dose is a very important factor modifying the healing phase. Our usual daily dose (200 r, measured with scattering, to each of two portals) produces, as far as the healing phase is concerned, a maximum effect. Should such radiation be continued, the healing phase would be indefinitely postponed by progressive destructive effects in 90 per cent of the cases. However, in approximately 10 per cent of the cases, the healing process can overcome the cumulative destructive effect of this dose, and initiate a healing phase during which skin and mucosa recover from radiation effects while treatment is being given.

When the daily dose is reduced by half to 100 r (measured with scattering) to each of two portals, a minimum threshold effect is obtained in that almost all patients, with rare exception, exhibit healing phases.

It must be remembered that 100 r to two

portals daily constitutes an experimental technic. In general, it is inadvisable to use less than 200 r to each of two portals daily.

The effect of the total dose on the healing process and the healing phase is obvious. Its practical importance arises in a case such as is illustrated in Figure 6, wherein it was early evident that we were dealing with a strong healing process, as was manifested by tardy and mild reactions. The continuation of treatment after the thirty-fifth day in an attempt to increase the total dose was inadvisable because the residual tumor cells by this time had matured sufficiently to exhibit the same physiologic functions as the skin, *i.e.*, the ability to adapt themselves to radiation effects during treatment. The lesion recurred several months later.

It might have been wiser to interrupt the treatments at the thirty-fifth day, wait one month for the healing process to have expended its energy, and then resume with a second course of treatments. Therefore, no attempt should be made to increase the total dose if it entails the administration of radiation during the healing phase.

3. *Individual Susceptibility.*—During the healing phase this is of enormous significance, whereas during the destructive phase, the dominant destructive phenomena tend to produce constant biologic effects.

Individual susceptibility is a potent force modifying the prognosis and is responsible for a great variety of responses to radiation throughout a wide range. In a previously reported series of 126 cases, nine patients were markedly hyper-susceptible, and 22 were markedly hypo-susceptible to radiation effects.

Hyper-susceptibility of the skin and mucosa results in early and intense reactions which curtail the total dose that can be administered and renders the prognosis unfavorable. This hyper-susceptibility of the normal tissues is not reflected in the tumor. The clinical effects naturally manifest themselves during the destructive phase.

Hypo-susceptibility of the skin and mucosa, however, is twice as common as hyper-susceptibility. It may be manifested as a primary capacity to withstand larger than usual doses of radiation—radio-immunization (Fig. 6), or a strong healing phase, which is a secondarily evolved mechanism occurring only in response to unit doses of radiation. We cannot say whether or not primary radio-immunization and secondary strong healing phase result from the same processes. Essentially, however, it is the mechanism of the healing process which defines the potency of these behavior patterns.

The importance of these principles lies in the fact that the behavior of the healing processes in the skin and mucosa is reflected to an extent in the behavior of the tumor. Thus we have shown previously (4) that if the epithelitis commences on the fifteenth day or later, primary shrinkage of the tumor is apt not to occur. Apparently the tumors of such radio-immune patients are relatively radio-incurable.

We have also shown (4) that if primary shrinkage has seemingly been attained by external radiation alone, and a second-degree epithelitis and epidermitis not obtained (due to a strong healing or adaptation factor), the tumor will recur.

In Figure 7 is observed a Grade I epidermoid carcinoma of the tongue treated with one-half the usual daily dose. The small unit dose permitted the healing process to gain ascendancy and initiate the healing phase on the thirty-fifth day. The low grade carcinoma was also sufficiently matured not only morphologically, but also physiologically, so as to be able to exhibit its own healing process, and, consequently, adapt itself to the radiation and to grow while the treatments were being given. The lesion in Figure 7 was a very mature one and was the earliest lesion to recur during the course of treatment. The more radiosensitive anaplastic tumors require a much longer period of time before such of their residual tumor cells as have not been destroyed can become functionally mature enough to proliferate during radiation bombardment.

These observations inspire speculations concerning the process of maturation of irradiated cells. When a tumor is irradiated, the more anaplastic cells are killed; the very mature cells are relatively unaffected, and an intermediate group of cells are rendered more mature. A biopsy of a Grade III epidermoid carcinoma of the tonsil taken on the twenty-eighth day of treatment, for instance, will reveal a much greater number of keratinized squamous cells and epithelial pearls than the original biopsy. There is not only a relative increase but also an absolute increase in the number of mature cells. We have observed this phenomenon of maturation in other tumors such as a malignant anaplastic adamantinoma which, under irradiation, developed mature recognizable ameloblasts, and a non-pigmented malignant melanoma which developed adult melanoblasts and became grossly pigmented. Many other examples are available of such maturation of cells under radiation.

It will be interesting to see whether or not we can confirm our early impressions that the healing process in tumor tissue can be conducted only by mature cells.

Histologically, epithelium and connective tissue "heal" differently. They both mature, but connective tissue becomes more static, whereas epithelial tissues become active. Connective tissue cells become more hyalinized, acellular, and avascular. The residual epithelial tumor cells also become more mature in a static fashion at first. However, they soon become active again and proliferate. This would be the naturally expected difference between the *hyperplastic* connective tissue stromal cells and the *neoplastic* epithelial tumor cells.

4. *Daily Exposure Time and Dosage Rate.*—The daily exposure time is probably of little consequence in the healing phase. Its importance has been superseded or invalidated by the size of the dose, individual susceptibility, and continuity of the treatment.

5. *Continuity of the Treatment.*—Any break in the continuity of the treatment permits the healing process to gain ascendancy so that the healing phase starts earlier. (See discussion of continuity of treatment under "Destructive Phase.")

In Figure 8, through the negligence of the patient who was discomfited by the reactions, the treatments were interrupted after the twenty-fifth day for a period of twelve days. This lapse of time not only permitted the healing forces to gain increased momentum, but also projected the last few treatments into the healing phase, in which phase they had so little influence that the reactions healed in spite of continued radiation.

PERIODICITY

Coutard (6) first coined the term, *periodicity*, to express what he thought was cyclic alternations between radiosensitivity and radioresistance in the tumor cells occurring approximately every two weeks. Our analysis of his figures reveals that this hypothesis has not been well substantiated. We have, therefore, applied the term, *periodicity* (4), to the observed shifting of the balance of power between the destructive process and the healing process. The destructive phase is chiefly conditioned by radiation factors; the healing phase by the healing processes of the tissues. Each plays a significant rôle in the response of the skin, mucosa, and probably the tumor.

On the basis of these observations, it is suggested that in planning a course of treatments, an attempt should be made, among other things, to assay the healing factor for the individual patient (Figs. 5 and 6) by observing the time of appearance and the magnitude of the reactions. The size of the daily dose and the frequency of the treatments should be so arranged that the course of treatments should be completed within the first destructive phase (twenty-eighth to thirty-fifth day). If the treatments extend beyond that time, they should be interrupted for a month or so until the healing processes have expended their energy, before resuming with a second course of treatments.

In treating an undifferentiated radiosensitive tumor, it is fairly generally agreed that all radiation should be administered during the first destructive phase, preferably within from 21 to 28 days. For the differentiated advanced tumors, it has been suggested that a lower daily dose be employed and the treatments extended up to 45 days or more. We believe this to be inadvisable because the smaller daily dose permits the healing process to accelerate in potency more rapidly and because the treatments are extended into the healing phase, by which time the residual tumor has become matured morphologically and physiologically and will not only resist the impact of the rays, but may also grow during treatment. It is in the treatment of undifferentiated, slower growing tumors particularly that the healing processes must be considered. Therefore, we recommend a four weeks' course of treatment; a rest period for four weeks to permit the healing process to expend its forces, and then a second course of treatment. The time suggested for each course is naturally only approximate.

DISCUSSION

Definitions.—The *destructive phase* is that era in a course of protracted external radiation which occupies the first four or five weeks of treatment and during which the destructive effects of radiation on tissues are manifest.

The *destructive process* is that group of complex phenomena which produce cellulicidal effects.

The *healing phase* immediately follows the destructive phase, lasting approximately from four to six weeks. During this era, the healing phenomena are actively functioning and dominate the clinical and histologic picture.

The *healing process* is that group of complex phenomena which result in the healing of normal tissues either in the presence or absence of continued radiation; and which also result in the tumor adapting itself to radiation so as to proliferate in spite of continued radiation.

The term *adaptation process* or *phenomenon* (coined by Ewing) has been used by us as synonymous with the term, *healing process*. It is possible that as our ideas of this subject become more clarified, we may apply the term, *healing process*, to the normal tissues, and the term, *adaptation process*, to the tumor cells.

The *recovery process* has been so thoroughly explored by others (1, 2, 3) that we hesitate to apply a specific definition. In the first week or so of its activity, it is probably a passive recuperative phenomenon. After that time, it merges into the healing processes. This definition is only tentatively suggested.

Periodicity is a cyclic alternation of destructive phase with healing phase as a result of a shifting of the balance of power between destructive and healing processes. Since, in order to elicit periodicity, the destructive dose is maintained as a constant factor, it must be the healing process alone which actively and alternately fluctuates from a dominant to a recessive rôle.

In considering various suggested rhythms of administration of radiation, cognizance must be taken of the healing process. For instance, the administration of a short preliminary "preparation" course of x-ray treatments to sensitize the tumor as suggested by Coutard might very likely initiate a strong healing process and permit it to gain momentum rapidly because it is unopposed by the strong destructive effects of the larger daily doses within the usual therapeutic range.

The same criticism might be directed against the inverse pyramid rhythm, *i.e.*, starting with a very small dose and then gradually increasing it. However, if a patient should be receiving 200 r a day to each of two portals, and should one become aware early in the course of treatments that the patient has a strong healing process—by virtue of tardy onset and slow ascent of the reactions—then one might properly introduce an inverse pyramid technic, though with doses which are larger than previously recommended, and

which lie in or above the usual therapeutic range. In Figure 6, it was realized on the fourteenth day that the patient was relatively radio-immune because of the tardiness of the reactions. The daily dose to each of two portals was raised from 200 to 340 r and, finally, to 408 r. In spite of this, his healing process was strong enough to depress the reactions to only a first degree intensity. His tumor (Grade III epidermoid carcinoma) which was apparently also endowed with this radio-immunity, failed to disappear as would ordinarily be expected.

The Holfelder technic (8) entails the administration of initial large daily doses, with a progressively decreasing increment. On the basis of our experiences, these later decreasing doses are too small to be effective and their administration is extended into the healing phase. Thus the latter part of the radiation is probably ineffectual except against the exceedingly radiosensitive tumors. However, if this course of radiation is confined to three or at the most four weeks, and a true saturation is maintained at a level of a second degree intensity, and if no further radiation is given once the healing phase sets in, then the healing process would not reduce the effectiveness of the radiation.

SUMMARY

The phenomena resulting from protracted fractionated radiation may be divided into two phases, the destructive phase and the healing phase. Each phase has specific characteristics and is modified to varying degrees by the quality of the radiation, the size of the daily dose, individual susceptibility, the daily exposure time, and the continuity of the treatment.

The healing process itself does not function at a constant rate. Its fluctuating prowess determines whether destructive or healing phenomena dominate the clinical picture. It is this cyclic alternation of destructive phase with healing phase that can be termed periodicity.

The extent to which the character of the skin and mucosal reactions are reflected in the tumor probably depends upon the latter's degree of differentiation and consequently its morphologic and physiologic resemblance to the parent tissue.

During the healing phase, residual tumor cells have usually been matured by irradiation and they too have adapted themselves to radiation effects. It is, therefore, recommended that during a prolonged course of radiation no treatment be given during the healing phase.

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BARIUM RUBBER DRAINS[1]

SURGICAL DRAINAGE TUBES THAT ARE VISIBLE BY X-RAY

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RUBBER drains are widely used in surgical procedures and occasions often arise when it is desirable to know their exact location. In some instances, the position of a drain may change to such an extent that it is no longer effective. In others, there may be a question of whether all or a part of the drain inserted at operation still remains. In any case it would be an advantage to be able to demonstrate the presence and location of such drains by x-ray examination.

This is seldom possible because few of the drains now in use are radiopaque. Pure rubber is not, and does not cast an x-ray shadow in contrast to the surrounding tissues. The radiopacity of any rubber compound is dependent on materials mixed with the rubber during manufacture, and although some compounds do contain radiopaque materials such as zinc oxide or titanium dioxide, their percentage is variable and there is seldom any ready means of determining such content. Rubber drains of known radiopacity are desirable, and various compounds have been tested with the following qualifications in mind:

1. *Opacity.*—A drain must be sufficiently opaque to x-rays to be easily seen in any part of the body.
2. *Physical Properties.*—It must retain the qualities of elasticity, durability, and resistance to sterilization which the surgeon demands.
3. *Chemical Properties.*—It must contain no chemicals or compounds which might be injurious to the patient, either locally or through absorption.
4. *Identification.*—It must be marked or colored so that it is easily distinguished from the drains now in use.
5. *Cost.*—It should be little if any more expensive than the drains now used.

For test purposes, the thin, "cigarette" type of drain was used as it was felt that if this type could be made sufficiently radiopaque, the thicker drains should present no difficulties.

Barium sulphate was selected for the opaque ingredient because it was found to give the greatest density with the least alteration of the physical properties of

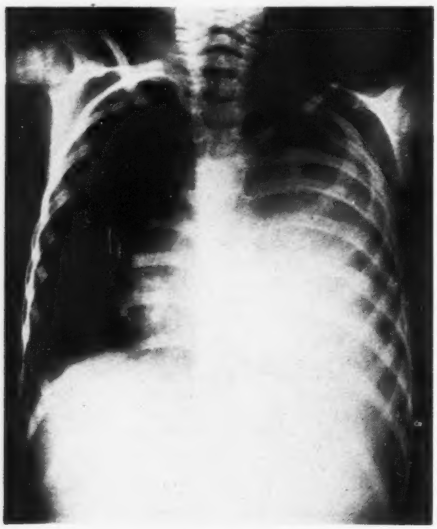

Fig. 1 (Case 1). Upright chest film taken after withdrawal of 15 c.c. of thick yellow pus and injection of 10 c.c. of air into the left pleural cavity. A fluid level is seen at the left apex with thickened pleura extending along the chest wall above it. The heart is displaced to the right by the fluid. There is a healed resection of the seventh left rib. Although sufficient radiographic penetration was used to show the ribs on the left, no foreign body is evident. A rubber drainage tube was found in the left pleural cavity at operation.

[1] Read before the Twenty-fourth Annual Meeting of the Radiological Society of North America, at Pittsburgh, Nov. 28–Dec. 2, 1938.

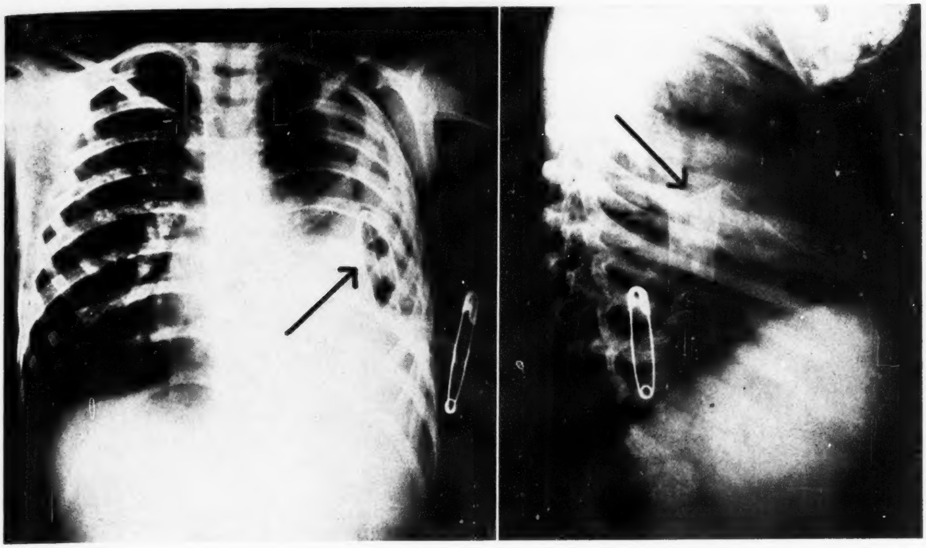

Fig. 2 (Case 1). Anteroposterior and lateral films of the chest following operation show a barium rubber drainage tube in the left pleural cavity. The tube is seen to be kinked upon itself and thereby rendered only partially effective.

rubber, and, at the same time, it is chemically inert. Different percentages were tried from 10 to 100 per cent by weight. It was found that the greatest amount which could be used without altering the elasticity of the rubber varied from 40 to 50 per cent by weight (between 8 and 10 per cent by volume).

This percentage was found to be in excess of that required for satisfactory visualization. Thin rubber drains composed of 25 per cent barium sulphate were readily demonstrable through the abdomen of an obese patient. The slight increase in actual weight in the thin rubber was not objectionable. It follows that an even lower percentage of barium can be used in the thicker drains and still give the same degree of radiopacity.

To avoid confusing these drains with others in the operating room, a brilliant scarlet pigment (chlornitraniline red) of the same type employed in the manufacture of toy balloons was used. This pigment is known to be harmless in the quantities used and imparts a striking and easily distinguished color to the rubber.

There should be no appreciable increase in cost over that of the drains now in use. The actual materials are less expensive than those used in non-opaque drains because rubber is replaced by comparatively inexpensive barium sulphate.

These barium rubber drains have been

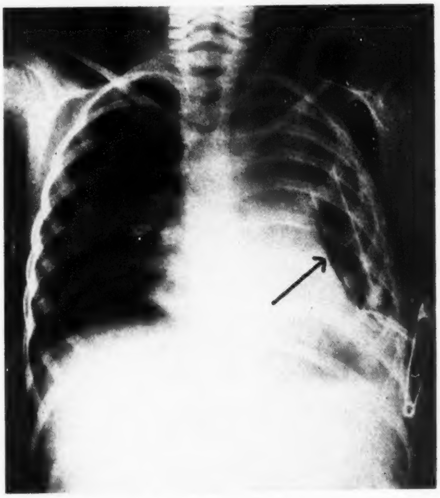

Fig. 3 (Case 1). Film taken after partial withdrawal and straightening of drainage tube. The tube is now in a more effective position.

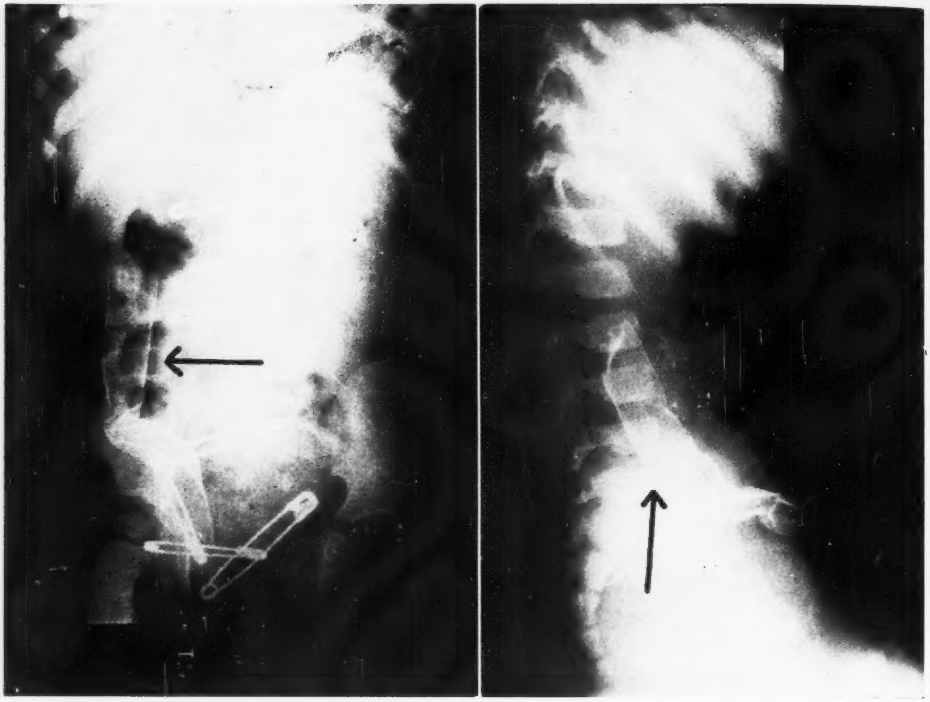

Fig. 4 (Case 2). Anteroposterior and lateral films of the abdomen taken five days after removal of a high retrocecal perforated appendix. A barium rubber drainage tube is seen high in the right lumbar gutter. Another tube of the usual type was placed retrovesically but is not visualized on the films.

used at the Children's Hospital in a number of cases, of which two are reported.

Case 1. L. C., a six-year-old white boy, was admitted to the Children's Hospital with a history of left empyema for which a rib resection had been done four months previously. A diagnostic tap of the chest yielded thick yellow pus, and an x-ray film taken at this time showed thickened pleura and a large amount of fluid in the left chest (Fig. 1). No foreign body was demonstrated.

Thoracostomy was performed and a rubber drainage tube was found in the pleural cavity. It was surrounded by tremendously thickened pleura and a large amount of pus. Rubber drains of the type described were inserted, and the films shown in Figures 2 and 3 demonstrate the opacity of the barium rubber drains that were used.

Case 2. R. T., a three-year-old white boy, was admitted to the Children's Hospital with a history of abdominal pain and vomiting for 36 hours. A diagnosis of acute appendicitis was made and appendectomy performed. The appendix was high and retrocecal in position and showed acute inflammation with perforation and peritonitis.

Two cigarette drains were inserted, one of the usual type and one composed of barium rubber. Films taken five days after operation (Fig. 4) show the barium rubber drain high in the right lumbar gutter in the best position for effective drainage. The other drain is not visualized.

Comment.—It is hoped that in the future no rubber articles will be introduced into natural or artificial body cavities unless they can be demonstrated by x-ray if the

need arises. With advances in processes of manufacture, particularly in the field of synthetic textiles, this may eventually include all other materials used in surgical procedures.

I wish to acknowledge my indebtedness to Mr. Raymond Bitter, research rubber chemist of Boston, for his helpful suggestions and painstaking work on the various compounds tested, and to thank the company he represents for the materials used.

NEW METHODS

TRANSNASAL BRONCHOGRAPHY

By ALEXANDER ORLEY, M.D., F.F.R., D.M.R.E.,
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In 1931,[1] I described jointly with Mr. Philip Franklin the transnasal method of bronchography with iodized oils. Up to that time we were using a special laryngeal speculum-forceps for the insertion of the catheter into the trachea. The method proved difficult and the addition of a laryngeal mirror to the bulky forceps within the narrow confines of the throat was definitely uncomfortable for the patient.

We then decided to look for some easier method. We reasoned that the most natural route to the lungs is through the nose, and that a gum-elastic catheter pushed into the nose and directed along its floor, is prevented from passing into the larynx only by retching or the swallowing reflex, which sets in as soon as the catheter touches the pharynx. It was, therefore, obvious that if we could prevent the excitation of either reflex by anesthetizing the throat, the catheter would naturally slip into the larynx. The assumption proved correct and we were astonished at the ease with which we were able to enter the trachea practically every time.

The method was eventually adopted by a large number of British radiologists, but is still little known abroad.

For all its ease, the method presents several "snags," which experience has taught us how to overcome. In the first place, the gum-elastic catheter tends to soften through the body heat and instead of entering the larynx may curl up in the pharynx, if it happens to butt against a pyriform fossa. This can be remedied by stiffening the catheter with a wire stilet, which can be withdrawn as soon as the catheter enters the larynx. Another complication is the laryngeal spasm provoked by the catheter touching the vocal cords. In some cases the spasm may appear very alarming and the patient may become so frightened as to forcibly withdraw the catheter. The spasm, however, is easily prevented by a few drops of the anesthetizing solution instilled through the catheter as soon as it reaches the entrance of the larynx, which can be ascertained by watching its progress through the open mouth.

The general procedure is as follows: Both nostrils and the pharynx are anesthetized with a 5 per cent solution of cocain or larocain by means of a nasal spray. The anesthesia of the pharynx must be complete and the touching of the posterior pharyngeal wall with the tip of the catheter must not provoke retching or a swallowing reflex.

A stiffened gum-elastic catheter No. 6 or 7 is then introduced into the straighter and freer nostril of the two and is gently pushed along the floor of the nose until it reaches the entrance of the larynx. Its progress can be watched through the open mouth. A few drops of the anesthetizing solution are then instilled through the catheter in order to render less sensitive the vocal cords and thus prevent laryngeal spasm. The catheter is then pushed further down. Often it passes straight into the larynx. Occasionally, however, when deviated slightly sideways, it butts against one of the pyriform fossæ. In such a case it should be slightly withdrawn, brought into the middle line by twisting it, and again pushed downward. The stiffening wire may now be removed and 4 c.c. of a 2 per cent anesthetizing solution injected by means of a syringe into the trachea through the catheter in order to suppress the coughing reflex, which would otherwise be provoked by the subsequent penetration of the oil into the bronchi.

The oil is injected under roentgenographic control and roentgenograms taken according to requirements.

The method as here described is simple, easy, and harmless and can be carried out even in nervous patients and children. The armamentarium is equally simple and cheap. With little experience the whole procedure should not take more than seven to ten minutes, a very important consideration in a busy department.

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[1] British Med. Jour., Nov. 7, 1931.

A NEW TECHNIC OF TAKING ROENTGENOGRAPHS OF THE UPPER RIBS

By ARTHUR R. BLOOM, M.D., *Detroit, Michigan*

In 1937, Gunnar Jönsson reported in the January-February issue of *Acta Radiologica* a new technic for demonstrating the sternum. The patient's thorax is immobilized by a tightly drawn compression band. The pulmonary shadows which usually disturb the clear appearance of the sternum are eliminated by the use of a short focal distance, long exposure time, and diaphragmatic breathing, the last

Fig. 1.

Fig. 2-*A*.

Fig. 2-*B*.

the primary principle of this technic. The cassette is placed directly against the anterior chest wall close to the sternum so as to minimize any indistinctness caused by the patient's moving. The tube should be placed at an angle of 25 degrees to the side, and the sternum projected into the right pulmonary field. The exposure should be between 10 and 15 seconds and the kilovoltage between 30 and 40. A Potter-Bucky diaphragm cannot be used.

I tried this technic and obtained results similar to those illustrated by Jönsson (Fig. 1). It occurred to me that equally clear views could be obtained of the upper ribs. As it is not necessary to angulate the tube, a Potter-Bucky diaphragm can be used. The resulting films give a clear picture of the ribs not obscured by lung tissue (Fig. 2-*A*) as compared to those taken by the conventional technic (Fig. 2-*B*).

The patient is placed flat on the Bucky table with the involved area over the center of the cassette. Thoracic respiration is stopped by tightly compressing the chest and the patient is instructed to breathe diaphragmatically. The tube is centered perpendicularly over the cassette and a 20-second exposure is made with corresponding lowering of the kilovoltage.

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THE BUSINESS SIDE OF RADIOLOGICAL PRACTICE

A Bulletin for Fellows and Residents in Radiology in Their Final Year of Post-graduate Training

(Concluded from last issue.)

Going into Practice.—If the radiologist decides to open a private office in an office building when he enters practice, his problem is a straightforward one. He rents a certain amount of space (including light, water, etc.) from the building, purchasing and installing certain necessary equipment. He selects a technician who will probably also act as secretary during the early years of his practice until his clientele permits him to increase his staff. He collects his fees from his patients and carries on his practice just as any other physician. For a few years his income is modest but it should gradually increase until it compares favorably with that of other medical specialties. He will find that the cost of practising his profession in a private office will vary from 40 to 60 per cent of the gross collections, depending upon the type of work he does and the part of the country in which he is located.

In addition to his office practice, the radiologist may seek a hospital appointment; or he may decide to accept a full-time hospital appointment. There are three general classifications of hospitals: those occupied exclusively by non-pay patients, those occupied by a combination of non-pay and pay patients, and those occupied by pay-patients alone. The first are exemplified by federal, state, and municipal hospitals, mental and tuberculosis institutions. Since no fees are collected from patients of these hospitals for medical services, the problem of private practice of medicine does not arise. The majority of physicians appointed to hospitals of this type are appointed on a salary basis and it is reasonable and equitable for the radiologist accepting such an appointment to be on a similar basis.

The second group of hospitals consists of a variable number of pay-patient rooms and non-pay-patient rooms and wards. In this type of institution, the radiologist should be appointed as are his colleagues on the medical staff and should practise medicine, as far as private patients are concerned, just as do those colleagues. Since the hospital provides space or space and equipment, it is necessary that the radiologist reimburse the hospital for the use of these facilities just as he would in his office building. This may be done in one of several ways. In many institutions the radiologist rents or leases the department, including its equipment, from the hospital, paying the latter a monthly rental. In others, the hospital is paid a unit cost for each case examined. The manner in which charity patients are handled in institutions of this type will vary according to the proportion of charity patients to pay patients. When the amount of pay work handled in the department will justify it, it is probably best for the radiologist to perform services for charity patients without charge, if this is the custom in other departments of the staff. Where the ratio of charity patients is high, however, it is frequently necessary for the radiologist to receive an honorarium from the hospital for the full time which he devotes to these patients.

In the third group of hospitals, those in which all admissions are pay patients, the most ethical and efficient arrangement is one under which the radiologist leases the space or space and equipment and pays the hospital a monthly rental. The monthly rental will vary according to the size of the hospital and according to whether the hospital provides only space or space and equipment. In actual practice it varies all the way from \$300 per month in a small hospital to as much as \$3,000 per month in very large institutions. A rental which exceeds 40 or 50 per cent of the monthly gross income of the department is probably too high.

Fiscal Arrangements.—There has been an unfortunate tendency for some hospitals to regard radiology as a part of hospital care and to look upon the radiologist as a technician employed by the hospital, filling an ancillary rôle in the practice of medicine. Some institutions have gone so far as to demand frankly a sizable

net profit from the fees earned by physician-radiologists practising in the hospital.[1] It is this tendency which is responsible for many of the current problems of radiology and which demands the concerted and unified attention of practising radiologists.

Because of the extensive equipment necessary for the practice of radiology and because of the fact that the hospital frequently owns this equipment, there have developed certain methods for handling the financial transactions for hospital radiology which are different from the methods employed for other clinical specialties. Although radiologists in an increasing number of hospitals have precisely the same relationship with a hospitalized patient as with one in their own private office—charging and collecting their own fees and reimbursing the hospital for the use of the facilities provided—the great majority of hospital radiologists to-day practise on a percentage basis, sharing the gross receipts with the hospital. Many radiologists are paid a salary by the hospital. While the number who collect their own fees and reimburse the hospital is, as stated above, increasing each year, they are in the minority.

In a study recently completed by the Inter-Society Committee, it was found that 36.4 per cent of radiologists working part or full time in one or more hospitals were employed by the hospital on a salary basis. This included, of course, government institutions, group clinics, and other institutions in which the entire medical staff was on a salary. Of the remainder, 47.3 per cent had a percentage agreement based upon gross income in about 65 per cent of the cases and on the net income in the balance. There were 7.3 per cent on a salary plus commission basis. There were 9 per cent on a rental or lease basis under which they reimbursed the hospital for use of its facilities. Most of the remaining 7.3 per cent charged and collected their own fees, having no financial arrangement with the hospital. A total of 21 per cent were found to collect their own fees.

Ethical Considerations.—For a complete discussion of fiscal matters pertaining to a hospital x-ray department, the reader is referred to Section 10 of the "Manual for Desirable Standards of Hospital Radiological Departments," issued by the American College of Radiology. In considering a proposed hospital connection under any type of fiscal arrangement, the radiologist should never lose sight of two fundamental principles: it is difficult for good medicine to be practised when a corporation renders the service through the medium of employed physicians, and no third party should be permitted to come between a doctor and his patient.

Failure to observe these principles will inevitably and ultimately react to the disadvantage of the patient, for whose benefit all principles of medicine were evolved. Responsibility for violation of these precepts may rest jointly upon the hospital and the radiologist, and can on applying to both parties have been enunciated by the American Medical Association. Section 7 of the "Essentials for a Registered Hospital," under which the Council on Medical Education and Hospitals approves hospitals for intern training, states, among other things, that, "It shall not be the policy of the hospital to make a profit from the department of radiology." Section 4, Article VI, of the "Principles of Medical Ethics" states, "It is unprofessional for a physician to dispose of his professional attainments or services to any lay body, organization, group, or individual, by whatever name called, or however organized, under terms or conditions which permit a direct profit from the fees, salary, or compensation received to accrue to the lay body or individual employing him. Such a procedure is beneath the dignity of professional practice, is unfair competition with the profession at large, is harmful alike to the profession of medicine and the welfare of the people, and is against sound public policy." It is to be emphasized that the question involved is not one of financial gain, it is the question of who shall control, guide, and develop the specialty of radiology.

As stated in the Manual, it is possible for a radiologist to conform with these principles under a salary or a percentage agreement. It has come to be recognized generally, however, that a rental or fee basis under which the hospital is reimbursed by the physician, instead of *vice versa*, is the sounder and more logical plan in the majority of cases. Specific recommendations for drawing up a rental agreement will be found in the Manual; in the Yearbook of Radiology, 1934, page 289, and in RADIOLOGY, **32**, 46, January, 1939.

Many leading hospitals employ a radiologist on a salary basis and many have percentage

[1] See Appendix B of the "Manual of Desirable Standards," American College of Radiology, for the American Medical Association ruling on this point.

arrangements. In some of these institutions, the agreement is satisfactory to both the hospital and the radiologist. The beginning practitioner, however, will hear many stories from his older colleagues of highly competent radiologists who helped to build up an outstanding hospital x-ray department while working on a salary basis, only to be replaced by one who was willing to accept a lower salary or commission when the hospital board of trustees found it desirable to supplement regular income with a profit from the radiological department. The young radiologist accepting a hospital appointment will serve himself, his specialty, and his patients by requesting that he be permitted to practise in the hospital on a fee-for-service basis the same as other members of the staff.

Some Harmful Influences.—A proper financial arrangement will usually prevent other problems which sometimes arise in the radiologist's relations with his hospital. It must be remembered that most hospitals are controlled and administered by laymen and the physician must be prepared to encounter certain tendencies and attitudes arising from this fact. During the growth of hospital insurance plans in recent years there has been a concerted effort on the part of some groups to define radiological services as a part of hospital care and to include the radiologist's services as benefits of the insurance contract. The proposal has been made, and in a few institutions it is a practice, to include radiological services as a part of the routine care of the hospital at an all-inclusive per diem rate. In a few localities attempts have been made to divide radiology into technical and professional phases with two charges, one for the "technical" service involved in producing the film and the other for the "professional" service of making an interpretation.

To a doctor who presumably is familiar with the fundamental precepts of his profession and cognizant of the profound importance of the personal equation in the application of medical science, there should be no necessity for pointing out the manifest evils created by such systems of practice. The radiologist beginning to practise should be informed concerning these problems and prepared to reveal objectively their harmful influences to the profession and to the public.

Advice to Laertes.—Science nor pedagogy has as yet discovered any substitute for experience as an imparter of knowledge. The young radiologist will learn much of practical value in the early years of his practice from association with his colleagues and experience with patients. In concluding this compendium, it may be worthwhile to submit a few admonitions to the radiological neophyte. If the neophyte were Laertes he would expect to hear something like the following from Polonius, an old and established radiologist:

Assuming that you have completed a prescribed course of graduate training and are eligible for examination by the American Board of Radiology, you are an accredited member of a fine and highly respected special profession. Speak of it as a profession and not as a mechanical procedure. Your clients are patients, not cases. Your office is an office and not a laboratory. In the hospital you work in a department, not a laboratory. You make examinations and render diagnoses; you do not take pictures or read films. In the case of therapy, of course, you treat the sick.

Perhaps you will accept a full-time hospital appointment when you begin practice, or you may open a private office. If the latter, you will send out a dignified announcement to physicians in the neighborhood notifying them that your services are available to their patients upon reference. On your office door you should announce yourself as a physician, M.D., with perhaps an additional single word, "Radiology," or "Roentgenology." Anything further is unnecessary and may be regarded as in bad taste. You should never, of course, advertise yourself or your office in a lay publication.

You should avoid publicity with the full knowledge that aggrandizing reports in the press usually impart a harmfully distorted notion to the average layman and subject you to critical mistrust by your fellow physicians.

The first thing you should do upon beginning your practice is to become a member of your county medical society. As a practising physician you must assume your share of the responsibilities resting upon the organized profession and you must take an active part in the work of your local medical society. You should affiliate with the local radiological society, if one exists, and you should apply for membership in at least one of the national radiological societies. As a member of the national radiological societies and of organized medicine, you should contribute to the scien-

tific and socio-economic activities which these societies encompass.

Assume your proper place in the civic life of your community, not because it is "good business," but in order that the profession of medicine may occupy its rightful rôle in community activities.

Radiology is a stern mistress; you must keep abreast of progress not only in your own specialty but in other medical and surgical fields. You should attend state and national society meetings whenever possible.

Never permit yourself to become a "film reader." Conduct yourself as a doctor, not as an "x-ray man." Give personal attention to every patient referred to you for examination, else you deny him the complete benefits of the art you practise.

RADIOLOGICAL SOCIETIES IN THE UNITED STATES

Editor's Note.—Will secretaries of societies please cooperate with the Editor by supplying him with information for this section? Please send such information to Leon J. Menville, M.D., 1201 Maison Blanche Bldg., New Orleans, La.

CALIFORNIA

California Medical Association, Section on Radiology.—*Chairman,* Karl M. Bonoff, M.D., 1930 Wilshire Blvd., Los Angeles; *Secretary,* Carl D. Benninghoven, M.D., 95 S. El Camino Real, San Mateo.

Los Angeles County Medical Association, Radiological Section.—*President,* E. N. Liljedahl, M.D., 1322 North Vermont Ave., Los Angeles; *Vice-president,* M. L. Pindell, M.D., 678 South Ferris Ave.; *Secretary,* Wilbur Bailey, M.D., 2007 Wilshire Blvd.; *Treasurer,* Henry Snure, M.D., 1414 South Hope Street. Meets every second Wednesday of each month at County Society Building.

Pacific Roentgen Club.—*Chairman,* Karl M. Bonoff, M.D., Los Angeles; *Members of Executive Committee,* I. S. Ingber, M.D., A. C. Siefert, M.D., D. R. MacColl, M.D.; *Secretary-Treasurer,* L. Henry Garland, M.D., 450 Sutter St., San Francisco. Executive Committee meets quarterly; Club meets annually during annual session of the California Medical Association.

San Francisco Radiological Society.—*Secretary,* L. H. Garland, M.D., 450 Sutter Street. Meets monthly on first Monday at 7:45 P.M., alternately at Toland Hall and Lane Hall.

COLORADO

Denver Radiological Club.—*President,* F. B. Stephenson, M.D., 452 Metropolitan Bldg.; *Vice-president,* K. D. A. Allen, M.D., 452 Metropolitan Bldg.; *Secretary,* E. A. Schmidt, M.D., 4200 E. Ninth Ave.; *Treasurer,* H. P. Brandenburg, M.D., 155 Metropolitan Bldg. Meets third Tuesday of each month at homes of members.

CONNECTICUT

Connecticut State Medical Society, Section on Radiology.—*Chairman,* Samuel M. Atkins, M.D., 63 Central Ave., Waterbury; *Secretary-Treasurer,* Max Climan, M.D., 242 Trumbull St., Hartford. Meetings twice annually in May and September.

DELAWARE

Affiliated with Philadelphia Roentgen Ray Society.

FLORIDA

Florida Radiological Society.—*President,* H. B. McEuen, M.D., Jacksonville; *Vice-president,* Joseph H. Lucinian, M.D., Miami; *Secretary-Treasurer,* John N. Moore, M.D., 210 Professional Bldg., Ocala. Meetings held in November and at the annual meeting of the Medical Association of Florida in the spring.

GEORGIA

Georgia Radiological Society.—*President,* James J. Clark, M.D., Doctors Bldg., Atlanta; *Vice-president,* L. P. Holmes, M.D., University Hospital, Augusta; *Secretary-Treasurer,* Robert C. Pendergrass, M.D., Prather Clinic, Americus. Meetings twice annually, in November and at the annual meeting of the Medical Association of Georgia in the spring.

ILLINOIS

Chicago Roentgen Society.—*President,* Roe J. Maier, M.D.; *Vice-president,* Adolph Hartung, M.D.; *Secretary,* Chester J. Challenger, M.D., 3117 Logan Blvd. Meetings the second Thursday of each month from October to May, except December, at the Hotel Sherman.

Illinois Radiological Society.—*President,* Cesare Gianturco, M.D., 602 W. University Ave., Urbana; *Vice-president,* Fred H. Decker, M.D., 802 Peoria Life Bldg., Peoria; *Secretary-Treasurer,* Edmund P. Halley, M.D., 968 Citizens Bldg., Decatur. Meetings quarterly by announcement.

Illinois State Medical Society, Section on Radiology.—The next meeting will be in Peoria, May 21–23, 1940. The officers are: *Chairman,* Warren W. Furey, M.D., 6844 Oglesby Ave., Chicago; *Secretary,* Harry W. Ackemann, M.D., 321 W. State St., Rockford.

INDIANA

The Indiana Roentgen Society.—*President,* Juan Rodriguez, M.D., 2902 Fairfield Ave., Fort Wayne; *President-elect,* H. H. Inlow, M.D., Shelbyville; *Vice-president,* Wemple Dodds, M.D., Crawfordsville; *Secretary-Treasurer,* Clifford C. Taylor, M.D., 23 E. Ohio St., Indianapolis. Annual meeting in May.

IOWA

The Iowa X-ray Club.—Holds luncheon and business meeting during annual session of Iowa State Medical Society.

KENTUCKY

Kentucky Radiological Society.—*President,* D. B. Harding, M.D., Lexington; *Vice-president,* I. T. Fugate, M.D., Louisville; *Secretary-Treasurer,* Joseph C. Bell, M.D., 402 Heyburn Bldg., Louisville. Meeting annually in Louisville, third Sunday afternoon in April.

MAINE

See New England Roentgen Ray Society.

MARYLAND

Baltimore City Medical Society, Radiological Section.—*Chairman,* Whitmer B. Firor, M.D., 1100 N. Charles St.; *Secretary,* Walter L. Kilby, M.D., 101 W. Read St. Meetings third Tuesday of each month.

MASSACHUSETTS

See New England Roentgen Ray Society.

MICHIGAN

Detroit X-ray and Radium Society.—*President,* Sam W. Donaldson, M.D., 326 N. Ingalls St., Ann Arbor;

Vice-president, Clarence Hufford, M.D., 421 Michigan Ave., Toledo, Ohio; *Secretary-Treasurer*, E. R. Witwer, M.D., Harper Hospital, Detroit. Meetings first Thursday of each month from October to May, inclusive, at Wayne County Medical Society club rooms, 4421 Woodward Ave.

Michigan Association of Roentgenologists.—President, C. K. Hasley, M.D., 1429 David Whitney Bldg., Detroit; *Vice-president*, M. R. Cooley, M.D., Mercy Hospital, Jackson; *Secretary-Treasurer*, C. S. Davenport, M.D., 609 Carey St., Lansing. Meetings quarterly by announcement.

MINNESOTA

Minnesota Radiological Society.—President, Leo G. Rigler, M.D., University Hospital, Minneapolis; *Vice-president*, Harry M. Weber, M.D., Mayo Clinic, Rochester; *Secretary*, John P. Medelman, M.D., 572 Lowry Medical Arts Bldg., St. Paul. These officers will assume their duties after the Summer meeting which will be held in connection with the Minnesota State Medical Society, May 31 to June 2, 1939.

MISSOURI

The Kansas City Radiological Society.—President, L. G. Allen, M.D., 907 N. 7th St., Kansas City, Kansas; *Secretary*, Ira H. Lockwood, M.D., 306 E. 12th St., Kansas City, Mo. Meetings last Thursday of each month.

The St. Louis Society of Radiologists.—President, Paul C. Schnoebelen, M.D.; *Secretary*, W. K. Mueller, M.D., University Club Bldg. Meets on fourth Wednesday of October, January, March, and May, at a place designated by the president.

NEBRASKA

Nebraska Radiological Society.—President, T. T. Harris, M.D., Clarkson Memorial Hospital, Omaha; *Secretary*, D. Arnold Dowell, M.D., 117 S. 17th St., Omaha. Meetings first Wednesday of each month at 6 P.M. in Omaha or Lincoln.

NEW ENGLAND ROENTGEN RAY SOCIETY

(Maine, New Hampshire, Vermont, Massachusetts, and Rhode Island.) *President*, Langdon T. Thaxter, M.D., Maine General Hospital, Portland, Maine; *Secretary*, Aubrey O. Hampton, M.D., Massachusetts General Hospital, Boston. Meetings third Friday of each month from October to May, inclusive, usually at Boston Medical Library.

NEW HAMPSHIRE

See New England Roentgen Ray Society.

NEW JERSEY

Radiological Society of New Jersey.—President, P. S. Avery, M.D., Middlesex Hospital, New Brunswick; *Vice-president*, J. G. Boyes, M.D., 912 Prospect Ave., Plainfield; *Treasurer*, H. A. Vogel, M.D., 1060 E. Jersey St., Elizabeth; *Secretary*, W. James Marquis, M.D., 198 Clinton Ave., Newark; *Counsellor*, A. W. Pigott, M.D., Skillman. Meetings at Atlantic City at time of State Medical Society, and Midwinter in Newark as called by president.

NEW YORK

Associated Radiologists of New York, Inc.—President, Henry A. Barrett, M.D., 140 East 54th St., New York City; *President-elect*, I. J. Landsman, M.D., 910 Grand Concourse, New York City; *Vice-president*, Frederic E. Elliott, M.D., 122 76th St., Brooklyn; *Treasurer*, Solomon Fineman, M.D., 133 East 58th St., New York City; *Secretary*, William J. Francis, M.D., 210 Fifth Ave., New York City. Regular meetings the first Monday evening of the month in March, May, October, and December.

Brooklyn Roentgen Ray Society.—President, A. L. L. Bell, M.D., Long Island College Hospital, Henry, Pacific, and Amity Sts.; *Secretary-Treasurer*, L. J. Taormina, M.D., 1093 Gates Ave. Meetings first Tuesday in each month at place designated by president.

Buffalo Radiological Society.—President, Chester D. Moses, M.D., 333 Linwood Ave.; *Vice-president*, Edward C. Koenig, M.D., 100 High St.; *Secretary-Treasurer*, Joseph S. Gian-Franceschi, M.D., 610 Niagara St. Meetings second Monday evening each month, October to May, inclusive.

Central New York Roentgen Ray Society.—President, Jesse Randolph Pawling, M.D., 305 Clinton St., Watertown; *Vice-president*, Albert Lenz, M.D., 613 State St., Schenectady; *Secretary-Treasurer*, Carlton F. Potter, M.D., 425 Waverly Ave., Syracuse. Meetings are held in January, May, and October, as called by Executive Committee.

Long Island Radiological Society.—President, Samuel G. Schenck, M.D., Brooklyn; *Vice-president*, G. Henry Koiransky, M.D., Long Island City; *Secretary*, Marcus Wiener, M.D., 1430 48th St., Brooklyn; *Treasurer*, Louis Goldfarb, M.D., 608 Ocean Ave., Brooklyn. Meetings fourth Thursday evening each month at Kings County Medical Bldg.

New York Roentgen Society.—President, Harry M. Imboden, M.D., 30 W. 59th St., New York City; *Vice-president*, Henry K. Taylor, M.D., 667 Madison Ave., New York City; *Secretary*, Roy D. Duckworth, M.D., 170 Maple Ave., White Plains, N. Y.; *Treasurer*, Eric J. Ryan, M.D., St. Luke's Hospital, New York City.

Rochester Roentgen-ray Society.—Chairman, Joseph H. Green, M.D., 277 Alexander St.; *Secretary*, S. C. Davidson, M.D., 277 Alexander St. Meetings at convenience of committee.

NORTH CAROLINA

Radiological Society of North Carolina.—President, Robert P. Noble, M.D., 127 W. Hargett St., Raleigh; *Vice-president*, A. L. Daughtridge, M.D., 144 Coast

Line St., Rocky Mount; *Secretary-Treasurer,* Major I. Fleming, M.D., 404 Falls Road, Rocky Mount. Meetings with State meeting in May, and meeting in October.

OHIO

Cleveland Radiological Society.—President, J. H. West, M.D., 10515 Carnegie Ave.; *Vice-president,* Harry Hauser, M.D., City Hospital; *Secretary-Treasurer,* H. A. Mahrer, M.D., 10515 Carnegie Ave. Meetings at 6:30 P.M. at the Mid-day Club, in the Union Commerce Bldg., on fourth Monday of each month from October to April, inclusive.

Radiological Society of the Academy of Medicine (Cincinnati Roentgenologists).—*President,* Archie Fine, M.D., 707 Race St., Cincinnati; *Secretary-Treasurer,* Justin E. McCarthy, M.D., 707 Race St., Cincinnati, Ohio. Meetings held third Tuesday of each month.

PENNSYLVANIA

Pennsylvania Radiological Society.—President, Louis A. Milkman, M.D., Medical Arts Bldg., Scranton; *First Vice-president,* James E. Ginter, M.D., Dubois; *Second Vice-president,* Alexander Stewart, M.D., Shippensburg; *Secretary-Treasurer,* L. E. Wurster, M.D., 416 Pine St., Williamsport; *President-elect,* Harvey N. Mawhinney, M.D., 6546 Darlington Road, Pittsburgh; *Editor,* William E. Reiley, M.D., Clearfield; *Assistant Editor,* Sydney J. Hawley, M.D., Danville.

The Philadelphia Roentgen Ray Society—President, H. Tuttle Stull, M.D., 3260 N. Broad St., Philadelphia, Penna.; *Vice-president,* Joseph E. Roberts, Jr., M.D., 403 Cooper St., Camden, N. J.; *Secretary,* Barton R. Young, M.D., Temple University Hospital, Philadelphia, Penna.; *Treasurer,* Fay K. Alexander, M.D., Chestnut Hill Hospital, Philadelphia, Penna.

The Pittsburgh Roentgen Society.—President, Zoe A. Johnston, M.D., 601 Jenkins Arcade; *Vice-president,* Prentiss A. Brown, M.D., and *Secretary-Treasurer,* Harold W. Jacox, M.D., 4800 Friendship Ave. Meetings held second Wednesday of each month at 4:30 P.M., from October to June at various hospitals designated by program committee.

RHODE ISLAND

See New England Roentgen Ray Society.

SOUTH CAROLINA

South Carolina X-ray Society.—President, Percy D. Hay, Jr., M.D., McLeod Infirmary, Florence; *Secretary-Treasurer,* Hillyer Rudisill, Jr., M.D., Roper Hospital, Charleston. Meetings in Charleston on first Thursday in November, also at time and place of South Carolina State Medical Association.

SOUTH DAKOTA

Meets with Minnesota Radiological Society.

TENNESSEE

Memphis Roentgen Club.—Chairmanship rotates monthly in alphabetical order. Meetings second Tuesday of each month at University Center.

Tennessee Radiological Society.—President, Steve W. Coley, M.D., Methodist Hospital, Memphis; *Vice-president,* Eugene Abercrombie, M.D., 305 Medical Arts Bldg., Knoxville; *Secretary-Treasurer,* Franklin B. Bogart, M.D., 311 Medical Bldg., Chattanooga. Meeting annually with State Medical Society in April.

TEXAS

Texas Radiological Society.—President, Jerome H. Smith, M.D., San Antonio; *President-elect,* C. F. Crain, M.D., Corpus Christi; *First Vice-president,* M. H. Glover, M.D., Wichita Falls; *Second Vice-president,* G. D. Carlson, M.D., Dallas; *Secretary-Treasurer,* Henry C. Harrell, M.D., 517 Pine St., Texarkana. Meets annually. Temple is place of next meeting, Oct. 20 and 21, 1939.

VERMONT

See New England Roentgen Ray Society.

VIRGINIA

Radiological Society of Virginia.—President, Fred M. Hodges, M.D., 100 W. Franklin St., Richmond; *Vice-president,* L. F. Magruder, M.D., Raleigh and College Aves., Norfolk; *Secretary,* V. W. Archer, M.D., University of Virginia Hospital, Charlottesville.

WASHINGTON

Washington State Radiological Society.—President, H. E. Nichols, M.D., Stimson Bldg., Seattle; *Vice-president,* George Cornett, M.D., Yakima; *Secretary-Treasurer,* Kenneth J. Holtz, M.D., American Bank Bldg., Seattle. Meetings fourth Monday of each month at College Club, Seattle.

WISCONSIN

Milwaukee Roentgen Ray Society.—President, H. W. Hefke, M.D.; *Vice-president,* Frederick C. Christensen, M.D.; *Secretary-Treasurer,* Irving I. Cowan, M.D., Mount Sinai Hospital, Milwaukee. Meets monthly on first Friday at the University Club.

Radiological Section of the Wisconsin State Medical Society.—Secretary, Russel F. Wilson, M.D., Beloit Municipal Hospital, Beloit. Two-day annual meeting in May and one day in connection with annual meeting of State Medical Society, in September.

University of Wisconsin Radiological Conference.—Secretary, E. A. Pohle, M.D., 1300 University Ave., Madison, Wis. Meets every Thursday from 4 to 5 P.M., Room 301, Service Memorial Institute.

EDITORIAL

LEON J. MENVILLE, M.D., *Editor* HOWARD P. DOUB, M.D., *Associate Editor*

THE RETROPERITONEAL LYMPH GLANDS AND MALIGNANT TUMORS

An article of particular significance appeared some months ago in a surgical journal which, because it might not be found in the available current medical library of the roentgenologist or the clinician, should receive greater publicity so that the specialists in fields other than surgical might be aware of its contents. I am referring to the paper by Desjardins[1] on the importance of the retroperitoneal lymph nodes in cases of malignant tumors. Desjardins points out that while the retroperitoneal nodes are the most important lymph nodes in the body, to the average man they are almost a *terra incognita* as to their importance in producing both clinical symptoms as well as physical signs.

In this paper Desjardins first presents the anatomy of the abdominal and pelvic nodes, following which is a section devoted to metastases from carcinoma, chiefly of the bladder, prostate, uterus and rectum, followed by a section on tumors of the testes and ovaries, and, lastly, by a very full discussion of the lymphoblastomas.

The symptomatology of abdominal lymph glandular involvement in carcinoma is difficult to analyze and often is improperly interpreted. Roentgenologic examination of the spine and pelvis may not indicate metastasis to these bony structures. If such is the case, backache, an invariable symptom, is probably due to metastasis of the tumor to the para-aortic lymph nodes and/or mesenteric nodes. Severe back pain is usually accompanied by roentgenologic evidence of skeletal metastases.

The metastases of tumors of the testes and ovaries will give much the same symptomatology as with carcinoma. Desjardins points out that when a patient has had a malignant tumor of the testis or ovary removed, if in a few weeks or months he begins to complain of symptoms such as backache, abdominal pain, bloating and belching, metastases to the para-aortic nodes should always be considered.

Involvement of the para-aortic nodes by lymphoblastoma of Hodgkin's disease or lymphosarcoma, is even more important, according to this author, than it is when there is a tumor of the lower portion of the body. There are two chief reasons for the importance of this involvement: first, the difficulty of diagnosis is such that in the so-called abdominal Hodgkin's, for example, it is often many months before the patient can obtain relief by proper treatment. The symptoms are extremely varied and may simulate many disorders. In the second place, it should be the extreme concern of the roentgenologist to realize that these lymph glands may be involved long before the more accessible axillary, cervical, or inguinal glands are affected, and that, furthermore, involvement of these superficial glands is of distinctly secondary importance as contrasted with the primary lymphoblastomatous changes of the retroperitoneal glands. The essential and necessary radium or roentgen irradiation of the retroperitoneal nodes is often overlooked and is frequently dismissed entirely because the involvement is unrecognized. The treatment of these glands is difficult and often accompanied by certain complications.

In the case of backache in which the pain is referred in an exaggerated fashion down an extremity, unless the primary lesion is recognized the treatment of the secondary condition is utterly wasteful. Treatment should be directed to the glands causing pressure or to the nerve or nerves in which actual infiltrative involvement has taken place.

After perusing this intelligent, thought-stimulating paper, one leaves it with the im-

[1] Desjardins, Arthur U.: Retroperitoneal Lymph Nodes: Their Importance in Cases of Malignant Tumors. Arch. Surg., **38**, 714–754, April, 1939.

pression that the medical man who diagnoses or treats systemic disease should be thoroughly familiar with its context.

JOHN H. MUSSER, M.D.

ANNOUNCEMENTS

PRESIDENT'S INVITATION TO THE ANNUAL MEETING

The Annual Meeting of this Society will be held one week later than ordinarily scheduled—from December 11 to 15, inclusive—at Atlanta, Georgia, the headquarters being at the Atlanta-Biltmore Hotel.

A good variety of radiologic and allied subjects will be presented, there being a general session each morning and dual sessions each afternoon—one for therapeutic and one for diagnostic subjects. The Refresher Courses, which were tried out last year and proved to be a popular and useful innovation, have been continued this year under the direction of Lewis G. Allen, M.D. They are rather more extensive this year, running all day Sunday and each morning of the meeting from 8:30 to 10:30. The afternoon Clinics have been omitted due to the enlargement of this feature.

Francis Carter Wood, M.D., will deliver the Carman Lecture on Tuesday evening. His subject will be, "The Biological Effects of Radiation." Probably no one in this country is better qualified than Dr. Wood to talk on this subject. The Society is very fortunate in getting him to address them.

The usual Membership Dinner, with reports from the Counselors, will be held on Monday evening; the Executive Sessions at 2:00 o'clock on Tuesday and Thursday afternoons just prior to the scientific programs, and the Annual Banquet with installation of the new officers on Thursday evening.

Registration for the Refresher Courses should be made at once. See the announcements in the Journal for the committees in charge of details. All applications for scientific exhibit space should also be made at once to Eldwin R. Witwer, M.D., Detroit, Michigan, who is in charge.

The local committee has been working very hard to provide social entertainment for the members and their ladies, and we are sure that traditional Southern hospitality will be in full evidence.

All radiologists and interested medical men are given a cordial invitation to attend the Scientific Sessions and visit the Exhibits.

RAYMOND G. TAYLOR, M.D.
President of the Radiological Society of North America

REFRESHER SERIES

Information concerning the Refresher Series, to be given in Atlanta beginning Dec. 10, will be found among the advertising pages in this issue. These courses will continue through Friday, Dec. 15, so that it will be possible for one to attend the Annual Meeting of the Radiological Society of North America while taking this post-graduate course in radiology. Facilities for enrollment have been provided, as will be seen by reference to the above-mentioned notice among the advertising pages.

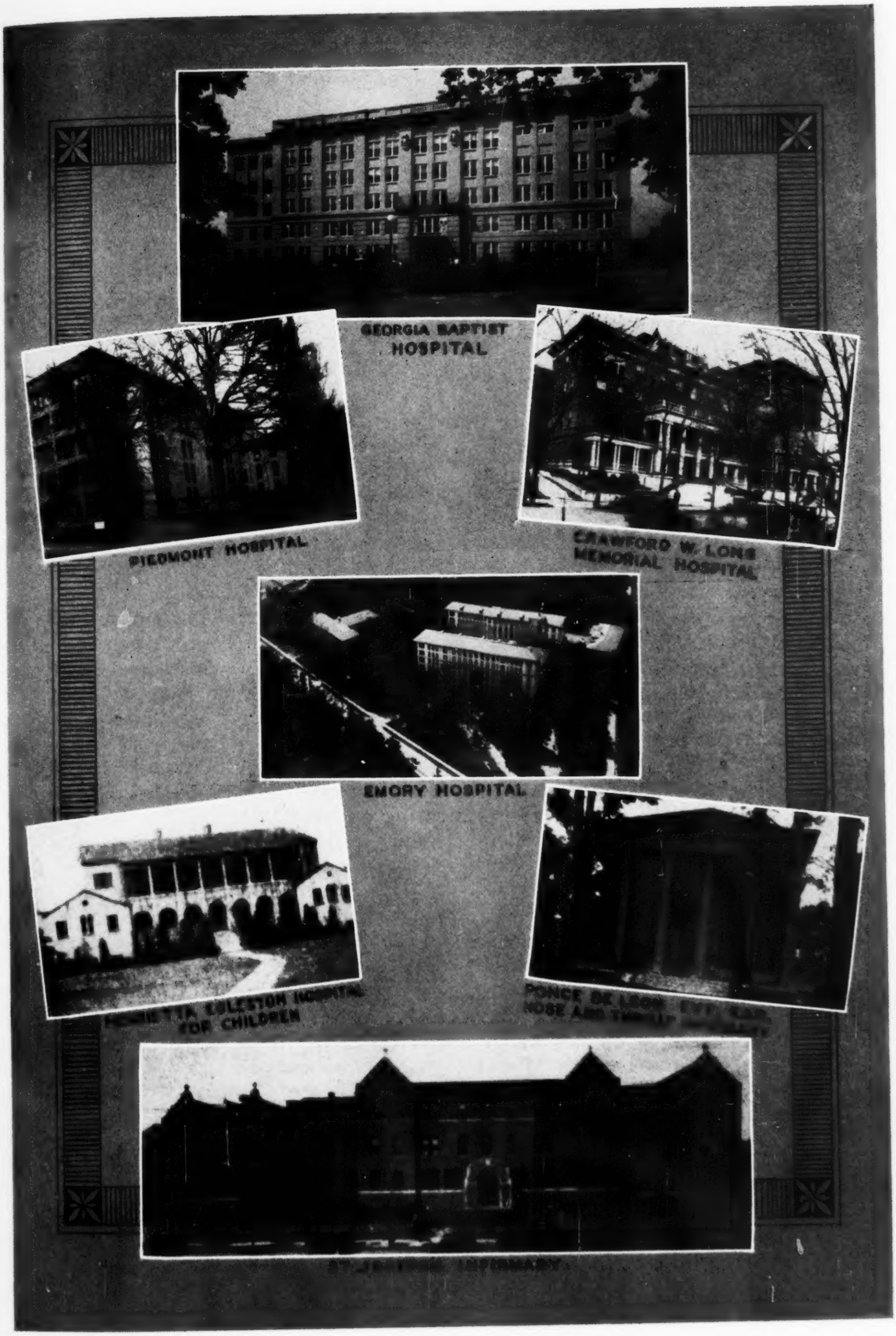
COMMUNICATIONS

CONFUSION OF NAMES

In a recent dispatch from London, published in a number of American newspapers, it was stated that several hundred foreign concerns had been placed on a "blacklist" by the British government. One of the concerns mentioned in the dispatch was "the Merck chemical company." Subsequent publication of the official list in full disclosed that the chemical company referred to was "Casa Chimica Merck" of Brazil, and "Merck Quimica Argentina" of the Argentine, South America.

To avoid any possible confusion in the minds of the American public, and to prevent any injustice being done, it is pointed out that the British government list did not refer to the firm of Merck & Co., Inc., manufacturing chemists, of Rahway, N. J., or Merck & Co., Ltd., of Montreal, Canada, regardless of the similarity of names.

Commenting on this situation, George W. Merck, President of Merck & Co., Inc., stated that the Rahway concern is an American company, incorporated under the laws of New Jersey; that its officers and directors are American citizens; that more than 99.5 per cent of its stock is owned by approximately a thousand persons in all walks of life, residing in the United States and Canada; that the company has no corporate connection with



Some of Atlanta's leading hospitals.

any concern outside of the United States with the exception of its wholly owned Canadian subsidiary, Merck & Co., Ltd., of Montreal, and that no foreign concern has any interest in Merck & Co., Inc.

Merck & Co., Inc., manufactures and distributes many drugs and chemicals for the medical, dental, pharmaceutical, and allied professions; for various branches of industry, and the general public.

NOTE OF CORRECTION

In the September, 1939, issue of RADIOLOGY the names of Desjardins and Smillie were transposed on pages 332 and 333 by the essayist, W. R. Scott, in his article on the use of "X-ray Therapy in the Treatment of Acute Pneumonia." His apologies are hereby offered.

BOOK REVIEWS

RÖNTGENATLAS DER LUNGENERKRANKKUNGEN (Roentgen Atlas of Lung Diseases). An introduction for physicians by Dr. W. BREDNOW, a.o., Professor of Internal Medicine and Roentgenology, Chief Physician of the University Clinic in Gottingden, and Dr. E. HOFMANN, Roentgenologist, Chief Physician of the Roentgen Division of the City. Published by Urban & Schwarzenberg, Berlin, 1938. Price: R.M. 13.50.

This book covers the important diseases of the lungs, and is to be especially recommended to the student of chest diseases. The illustrations are excellent reproductions of roentgenograms, and unusually well done. A study of the reproductions will be of definite value in differential diagnosis.

L'ELECTROENCEPHALOGRAMME NORMAL ET PATHOLOGIQUE (Electro-encephalogram, Normal and Pathologic). By IVAN BERTRAND, Director of the School of Hautes Études; JEAN DELAY, Hospital Physician, Hospital of Paris, and JACQUELINE GUILLAIN, Assistant in the Neurological Institute. A volume of 294 pages, with 94 illustrations. Published by Masson et Cie, Paris, 1939. Price: 90 francs.

It can be said truthfully that the time has almost arrived when electro-encephalography will be as important to the neurologist as is electro-cardiography to the cardiologist. A large mass of literature on the subject of electro-encephalography has accumulated, largely within the past few years, and is increasing each month. For the physician who wishes to familiarize himself with the apparatus, physical and physiologic principles involved in electro-encephalography, and with the interpretation of electro-encephalograms, this book can be recommended. The authors have done a commendable piece of work in summarizing the already extensive literature dealing with this subject, experimental as well as clinical. They also report an extensive series of personal observations. When dealing with controversial topics, the authors are careful to present both sides of the question.

Physicians who read this book will have little doubt of the great rôle electro-encephalography is destined to play in the future of neurophysiology, neurology, and psychiatry. While at the present time electro-encephalography finds its most practical application in the localization of intracranial lesions, there can be little doubt that valuable knowledge is being, and will be, gained by the application of electro-encephalography to many of the other problems which abound in neuropsychiatry.

One leaves the book feeling that there is ample justification for its existence, not only from the standpoint of the diffusion of knowledge concerning this newest addition to the neurologic armamentarium, but also because of the stimulating effect such a work is certain to have on future research. An excellent bibliography is appended to the work. The index is somewhat scanty, but is adequate. Occasionally, illustrations are poorly labeled and explained, and unfortunately are seldom referred to by number in the text, thus causing some slight difficulty in correlating the illustrations with the text. These, however, are minor defects, and do not detract greatly from the essential value of the book.

ABSTRACTS OF CURRENT LITERATURE

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THE FOLLOWING ABSTRACTORS HAVE CONTRIBUTED TO THIS ISSUE

S. Richard Beatty, M.D., of Denver, Colo.
Ray A. Carter, M.D., of Los Angeles, Calif.
James J. Clark, M.D., of Atlanta, Ga.
M. L. Connelly, M.D., of Chicago, Ill.
Joseph T. Danzer, M.D., of Oil City, Penna.
Percy J. Delano, M.D., of Chicago, Ill.
Sydney J. Hawley, M.D., of Danville, Penna.
John B. McAneny, M.D., of Madison, Wis.
Antonio Mayoral, M.D., of New Orleans, La.
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Willis A. Ward, M.D., of Chicago, Ill.

ABSTRACTS IN THIS ISSUE LISTED ALPHABETICALLY BY AUTHORS

ABNORMALITIES

A Case of Costo-vertebral Dystrophy. M. Laplume. Bull. et mém. soc. de radiol. méd. de France, **26**, 256, 257, April, 1938.

A case of hemivertebra, lying on the right, between the third and fourth thoracic vertebræ, is presented. This hemivertebra possessed a transverse process but no spinous process. The twelfth rib on the left was absent. There was a spina bifida of the fifth lumbar to the second sacral segments.

S. R. BEATTY, M.D.

Platybrachyspondylosis. Robert Guérin and A. P. Lachapèle. Bull. et mém. soc. de radiol. méd. de France, **26**, 282–290, April, 1938.

Reproductions of roentgenographs of a case of platybrachyspondylosis and a discussion of this condition are presented by the authors. In addition to the characteristic enlargement and flattening of the vertebral bodies, generalized in this case, the epiphyseal regions of the other bones show alterations of a chondrodystrophic type.

S. R. BEATTY, M.D.

A Case of Congenital Ankylosis of the Elbow. Billant, Dufour, and Thiboumery. Bull. et mém. soc. de radiol. méd. de France, **26**, 238–240, April, 1938.

Roentgenographs of the elbows of an eight-year-old girl show complete fusion of the radius and humerus without any evidence of a joint space, the architectural lines of the bones being continuous. A vestigial joint space existed between the ulna and humerus. The radius and ulna were not fused either proximally or distally.

S. R. BEATTY, M.D.

ACROMEGALY

Irradiation of the Hypophysis in Cutis Verticis Gyrata. Axel Renander. Acta Radiol., **19**, 254–258, September, 1938.

In the introduction to his article the author refers to a previous publication in the *Acta Radiologica* in which he tried to demonstrate that cutis verticis gyrata is no disease entity *per se*, but only represents a symptom of acromegaly.

By measurements of the volume of the hands and feet, before and after irradiation of the hypophysis, Renander was able to show a 10 per cent decrease in the volume of the hands and feet following radiation. In the course of one month three squares (right and left temporal regions, glabella) each received five treatments of 200 r.

The author is convinced that this improvement in the acromegalic phenomena following radiation of the hypophysis confirms his hypothesis that cutis verticis gyrata is of hypophyseal origin and represents a manifestation of acromegaly.

ERNST A. SCHMIDT, M.D.

ANIMAL EXPERIMENTATION

Investigations Regarding the Effect of Ultra-short Waves on Implanted Tumors. H. Langendorff and M. Langendorff. Strahlentherapie, **64**, 512, 1939.

The authors studied the effect of electric waves from 3.2 to 3.8 meters on the Ehrlich-Fischer carcinoma implanted in white male mice. A total of 200 animals was used, consisting of 117 treated and 83 controls. In not a single case could a specific effect of certain wave lengths on the tumors be found. Similar experiments were carried out, then, by combining the short electric waves with x-rays (60 kv., 5 ma., 400 r./min., 2,000 r effective in the tumor in one sitting). Forty-six animals were treated by x-rays only, 44 combined, and 60 served as controls. It appeared that 64.4 per cent more of the tumors were destroyed when treated with the combined method as compared with those treated by x-rays alone. The authors conclude, therefore, that by combining x-ray therapy with ultra-short waves a definite increase in the percentage of cures of malignant tumors is to be expected.

ERNST A. POHLE, M.D., Ph.D.

The Action of Chemical and Physical Agents on *Clostridium welchii* and its Toxin. Francis E. Colien. Jour. Lab. and Clin. Med., **24**, 245–248, December, 1938.

The author prepared pure cultures of *Clostridium welchii*. He irradiated them and toxin from them, only to find the toxicity was but slightly decreased when tested on pigeons. However, he states the toxin in the presence of sterile tissue, treated or not treated with x-rays, was found gradually to lose its toxicity for pigeons. According to him there are certain substances present in the tissues, such as glutathione, hydrogen peroxide, and to a lesser extent cystine, that may play a part in detoxifying or altering toxin, and these substances may be liberated or stimulated to increased activity by x-rays.

W. A. WARD, M.D.

The Effect of Gamma Radiation on Cells *in vivo:* Single Exposures of the Normal Tadpole at Room Temperature. F. G. Spear and A. Glücksmann. British Jour. Radiol., **11**, 533–553, August, 1938.

Experiments with two series of tadpoles were made, one series from three to six weeks after hatching, and another from 11 to 14 weeks after hatching. The animals were exposed to as nearly an even distribution of gamma radiation as was possible. Serial sections of the tadpoles were made following the irradiation.

In the younger animals, the following series of changes were observed: (1) from one to three hours after irradiation, a period of reduced mitotic activity, during which the prophase count was first reduced, followed by the other phases; (2) from three to nine hours after irradiation, a small temporary return of mitotic activity, followed by a transitory appearance of cellular degeneration; (3) from nine to 48 hours,

many mitotic figures appeared, mostly prophase, with a second increase in degenerated cells (many of the mitotic figures were abnormal); (4) from two to 12 days, slow recovery, cell degeneration gradually disappeared, mitotic phase count returned toward normal ratio, and (5) from 12 to 72 days, restoration and maintenance of normal conditions.

In the second series of older animals, observations were made at 24-hour intervals for seven days. In 24 hours, the number of prophases was normal, and remained so throughout. Metaphase and telophase were reduced to about 50 per cent of normal, and great numbers of degenerate cells were found. At 48 hours, the telophase count had increased and there were fewer degenerated cells. By the end of four days, the metaphase count exceeded the telophase count, and all degenerated cells had disappeared. By the seventh day the mitotic count was normal. Compared with the younger animals, the effect of radiation does not last so long.

These findings are very similar to those found in tissue cultures. The initial effect of irradiation is to postpone visible mitosis, while the cells that have already begun complete the process. The degenerating cells apparently represent a group of potentially dividing cells which cannot divide as a result of the irradiation effect. Three attempts at mitotic activity are made, one three hours, one nine hours, and the last and final attempt 12 days after exposure. In the first attempt, a cell either divided or degenerated; in the second, a majority of the cells entered the prophase and then broke down. The longer the interval between exposure and observation the greater is the number of dividing cells degenerating in the later stages of mitosis. The third attempt is successful and the cells return to normal.

The rapidity with which recovery occurs in the older animals, which are in the metamorphosing stage, is striking. It is about twice the rate of recovery in the younger ones.

S. J. HAWLEY, M.D.

APPARATUS

A New Diagnostic Method in Diseases of the Heart Employing Long and Short Waves. Rosa. Bull. et mém. soc. de radiol. méd. de France, **26,** 560–563, October, 1938.

Using a cathode ray oscillograph, the author registers the changes in a high frequency field caused by the contractions of the heart. The field is maintained by a generator employing about two watts wave length of six meters. The patient lies on a wooden couch between the two circular condensers of the apparatus, one above and one below the region of the chest corresponding to the heart. The anode current undergoes a rhythmic reduction during contraction and an increase during diastole. These variations are registered by means of the cathode ray tube on a film moving at the rate of 6 cm. a second.

The curves do not resemble the electrocardiogram or phonogram. They represent, essentially, the variations of the form and size of the heart and the force of contraction. The general form will change also with the position of the muscle. Any factor influencing the size or contractility of the heart will affect the shape of the curves. Among these factors are variations in size of the vascular bed, drugs such as caffeine, digitalis, and adrenalin, fatigue and anatomic variations or lesions.

The clinical value of the procedure is difficult to predict as yet, although the study of arythmias has been enriched by new revelations concerning the quantitative values of irregular contractions.

S. R. BEATTY, M.D.

Star-shaped Radium Carrier for Simultaneous Vaginal and Intracervical Radium Application. E. Redenz. Strahlentherapie, **64,** 368, 1939.

The author describes a star-shaped radium applicator which is attached to a hollow tube. The tube will admit three screens of 10 mg. radium each, and the star-shaped attachment seven screens of 10 mg. each. It proved highly efficient in combined treatment of vagina and cervix; one great advantage is the ease of application in cases with narrow vagina and high portio.

ERNST A. POHLE, M.D., Ph.D.

A Year of Pulmonary Stratigraphy by the Method of Vallebona, Modified. G. Ronneaux. Bull. et mem. soc. de radiol. méd. de France, **26,** 494–503, July, 1938.

Pulmonary stratigraphy is a distinct advance in the study of the chest, providing information not available with conventional technics. The author uses a modification of Vallebona's apparatus, unique in that the patient and film are both turned synchronously on vertical pivots while the tube remains fixed. This apparatus has the advantage of being relatively inexpensive, compact, and independent of the tube. A selection of cases is essential, as there is no necessity for the added examination if previous films adequately demonstrate the pathology. In 90 per cent of such selected cases, stratigraphy proved to be of positive diagnostic value.

S. R. BEATTY, M.D.

Planigraph and Biotome. J. Massiot. Bull. et mém. soc. de radiol. méd. de France, **26,** 618–620, October, 1938.

The author and his colleagues, after two years of experience, are convinced that apparatus for planigraphy employing circular movement are much superior to those employing rectilinear motion of the tube and film.

S. R. BEATTY, M.D.

Report on the Evolution of Radiotherapy. Lamarque. Bull. et mém. soc. de radiol. méd. de France, **26,** 340–342, May, 1938.

Actually, roentgen therapy at high tensions has not as yet been proved of marked superiority to roentgen

therapy at from 200 to 300 kv. It is too soon for any final decision as to its relative value, however.

The possibilities of neutron therapy and of artificial radio-activity should also engage our attention, as new problems of universal interest.

S. R. Beatty, M.D.

Presentation of a Stratigraphic Apparatus. Delaborde. Bull. et mém. soc. de radiol. méd. de France, **26**, 488, 489, July, 1938.

The author describes the "Stratix" built by the Compagnie Generale de Radiologie. This apparatus has been designed to permit not only stratigraphy (rectilinear motion) but also radioscopy, radiography, and teleroentgenography.

S. R. Beatty, M.D.

Planigraphic Results Obtained with the Biotome. J. Massiot. Bull. et mém. soc. de radiol. méd. de France, **26**, 486, July, 1938.

Massiot evinces a preference for the planigraph of Ziedses des Plantes and the biotome of Bocage, as circular or epicycloidal movements of tube and film are more efficacious in blurring out superimposed planes than rectilinear movement.

S. R. Beatty, M.D.

ARTERIOGRAPHY

Arteriography. Moysés Barmak. Ann. paulist. de med. e cir., **36**, 567–580, December, 1938.

It was not until the year 1923, that arteriography *in vivo* was attempted. Since then it has offered practical means of study of the arterial tree. The works of Egas Moniz and Reynaldo dos Santos are outstanding in this field. The development of a suitable contrast medium had much to do with the advancement of the method. The writer sets forth the following requisites for an ideal solution: (*a*) Opaque to x-rays; (*b*) innocuous to the arterial walls; (*c*) innocuous to the circulation; (*d*) not injurious to the organism; (*e*) beneficial action on the organism. Eight of the media used are reviewed but none is entirely satisfactory if judged by the ideals set forth above, although four of them are sufficiently innocuous for practical purposes. Thorotrast and uroselectan are preferable, and perabrodil, when injected into an exposed artery, is recommendable, but it should be kept in mind that when this substance is injected cutaneously or subcutaneously it will cause necrosis and tissue slough.

The following technic is used: having selected the desired opaque medium to be used, the patient is placed on the table, the skin cleaned, and the artery exposed, or the solution injected by direct subcutaneous puncture. When dealing with nervous individuals, a 1 per cent solution of novocaine injected as an anesthetic will be useful in securing immobility of the limb when the exposure is made. If perabrodil is used, anesthesia with evipan achieves the same immobilization. From 20 to 25 c.c. is the amount of solution advised for the lower extremity and from 12 to 15 c.c. for the upper. A needle 5 cm. long by nine-tenths mm. in caliber should be used. The artery is compressed with the left hand above the site of puncture, while the needle is injected with the right, care being taken that the force of the blood does not carry the fluid into the syringe. The injection should be made in ten seconds or less at an even pressure, the x-ray exposure to follow immediately.

While the author believes that serious accidents are relatively infrequent, mild accidents are common. It is the writer's belief that 10 per cent of the roentgenograms are not satisfactory, and he believes these results to be due to errors during the injection or puncture of the vessel, flaws in the roentgenological technic, or inability of the patient to co-operate. Serious circulatory diseases of the extremities, very acute arthritis, serious hepatic or renal insufficiency, and serious general systemic diseases are counter-indications to arteriography.

In spite of all its drawbacks, arteriography is a highly useful method of arterial exploration and it should be practised whenever indicated.

Antonio Mayoral, M.D.

A Simple Method of Arteriography of the Leg. Dimtza and Jaeger. Bull. et mém. soc. de radiol. méd. de France, **26**, 22–29, January, 1938.

The authors describe their technic of arteriography and present several case reports demonstrating the diagnostic and occasional therapeutic results of this procedure. Using a compressed air reservoir they inject from 20 to 30 c.c. of thorotrast, at from 1.8 to 2 atmospheres pressure, into the femoral artery, exposing it only when necessary. Instead of using multiple films they employ films 20 by 90 cm., in screens correspondingly large. They find that the use of single films simplifies the procedure considerably.

S. R. Beatty, M.D.

ARTHRITIS

The Treatment of Rheumatoid Arthritis with Large Doses of Vitamin D: A Clinical Evaluation. Nathan R. Abrams and Walter Bauer. Jour. Am. Med. Assn., **111**, 1632–1639, Oct. 29, 1938.

Knowing that general decalcification is a common and at times an early manifestation of rheumatoid arthritis, one might be led to suspect that certain patients with rheumatoid arthritis suffer from some type of disease of calcium and phosphorus deficiency. If such were the case, then this observation of Dreyer and his co-workers might be of etiologic as well as of therapeutic significance. Detailed studies of the calcium and phosphorus metabolism of patients with rheumatoid arthritis have failed to reveal metabolic changes of sufficient degree to allow one to conclude that the generalized decalcification is secondary to a primary disturbance of calcium and phosphorus metabolism.

Since rheumatoid arthritis is a chronic disease of years' duration, characterized by remissions and re-

lapses of varying length and degree, the course of the disease may vary considerably from patient to patient. Therefore, in a study of this type, designed to determine the therapeutic effectiveness of a particular form of therapy, one must of necessity require that each person serve as his own control.

The effect of massive doses of vitamin D were observed on 18 patients with rheumatoid arthritis. Observations prior to treatment showed that all the patients were in a stationary or slowly progressive stage. Subjective improvement lasting throughout the period of therapy was observed in eight cases. In only three instances was this accompanied by objective improvement and in only one was it marked. Such improvement was short-lived when therapy was discontinued. Only five patients showed a significant alteration in the curves of their sedimentation rate, and only two of these were improved subjectively and objectively. Five patients gained weight during treatment. Their results indicated that the administration of massive doses of vitamin D in rheumatoid arthritis was of little or no value in altering the course of the disease. The general effects of the larger doses did not appear significantly different from those observed with the usual therapeutic doses and did not justify the expense and dangers involved.

CHARLES G. SUTHERLAND, M.D.

BACKACHE

Fascial Adhesions in Pain Low in the Back and Arthritis. Charles Murray Gratz. Jour. Am. Med. Assn., **111,** 1813–1817, Nov. 12, 1938.

Fascial planes function as joints, synchronizing motion between muscles, groups of muscles, nerves, and blood vessels. Traumatic and inflammatory lesions may involve these planes, resulting in myosynovitis or fascial adhesions. These are believed to be competent producing causes of muscular pain by involvement of the nerves and of limitation of the normal range of motion in the joint by retardation of the gliding mechanism of the muscles. A diminished power of repair of lesions involving the lower part of the back may be caused by arthritis, if this term applies to the fascial as well as to the osseous joints.

Biochemical studies of fibrous tissues were co-ordinated with gross and histologic studies of anatomy, with roentgenograms, and, finally, with histologic studies. The therapeutic application of the aforementioned concepts to fascial surgery, with case reports, are included in this article.

Describing a joint as a space functionally designed for motion, to include osseous joints, the tendons moving in their sheaths, and the fascial spaces functioning as joints, the use of a contrast medium was added to the roentgenographic study of lesions involving the fascial planes. Air insufflation was used, for which special equipment was devised by the author, and it was always done as a hospital procedure. The dangers of infection and embolism were recognized; but 398 cases were reported in which there were no complications. The clinical applications of this study were believed to show that the method can be safely applied over a period of years.

CHARLES G. SUTHERLAND, M.D.

Spondylolisthesis as an Etiologic Factor in Backache. Henry W. Meyerding. Jour. Am. Med. Assn., **111,** 1971–1976, Nov. 26, 1938.

Backache is the most common symptom of spondylolisthesis and downward displacement of the lumbar spine its most common deformity. Males are afflicted in the majority of cases; trauma and congenital defects are the most important etiologic factors; obesity, occupational strain, and pregnancy may produce or aggravate the symptoms and increase the deformity. Old injuries, sustained months or years previously, may be the (unrecognized) factors which have produced the subluxation, but the most important factors are congenital anomalies which result in weakness in the lumbosacral region.

General practitioners are often called upon to fix responsibility for, and to estimate the duration and degree of, such disability. On relief of symptoms, they are in a position to return the patient to his occupation and to adjust a fair rate of compensation. Present knowledge of the deformity makes it possible for the physician to recognize it, ascribe responsibility to the factors involved in its production, and relieve the symptoms.

The number of diagnoses of spondylolisthesis has increased *pari passu* with our increase in our clinical knowledge and roentgenologic skill and experience. There is now but little justification for continued lack of recognition of this deforming and disabling lesion.

Ten per cent of the patients in the author's series had no complaint and the recognition of the lesion was incidental to examinations for other diseases or deformities. It is possible to make the diagnosis following inspection and palpation, but one must rely on the roentgenologic examination for accurate grading of the degree of deformity and for determining the site affected and the type of anomalies present, which may be factors in its production. Roentgenologic examination will also differentiate tuberculosis, fracture, arthritis, or tumor. Anteroposterior roentgenograms cannot be relied on to disclose forward displacement; lateral roentgenograms permit gauging of the exact degree of deformity.

About 70 per cent of the author's series of patients with spondylolisthesis were farmers, laborers, or housewives. This seemed to confirm the important effect strain and trauma have on many people, who, had their employment been less strenuous, might have gone through life without symptoms. A history of trauma was obtained in about 48 per cent of cases; in some, it could not possibly have been a factor in the causation of the deformity; in others, the history furnished irrefutable proof of the traumatic nature of the condition.

In 82 per cent of the cases, the deformity consisted

of forward slipping of the fifth lumbar on the sacrum; 11.3 per cent had forward slipping of the fourth lumbar vertebra on the fifth. Less than 1 per cent had involvement of the third and fourth lumbar vertebræ or of the second and third lumbar vertebræ; in only one case was double displacement noted. Reverse spondylolisthesis was observed in 4.4 per cent of the cases.

Treatment varies with the type of case: the patient is placed in the recumbent position and traction, by means of Buck's extension, is applied—casts, lumbosacral supports, corsets reinforced by stays, and bone-graft operation in instances in which these measures fail.

Charles G. Sutherland, M.D.

THE BLOOD

Leuko-erythroblastic Anemia. John McGrath. Irish Jour. Med. Sci., **156**, 755–761, December, 1938.

The characteristic feature of this condition is the numerous immature red cells in the circulating blood. Immature myeloid cells are present but in a lesser degree. The number and character of the megaloblasts excludes "aleukemic leukemia."

The blood picture appears in: (1) carcinomatosis in which there is extensive bone metastasis; (2) myelomatosis may show the same picture; (3) myelosclerosis often shows leuko-erythroblastic anemia (histologic examination of the bone is the only definite method of establishing this condition); (4) Cooley's erythroblastic anemia, occurring in children of Mediterranean stock, may show this hemogram but the bone changes are similar to those of osteitis fibrosa; (5) Albers-Schönberg disease may show this blood picture, and (6) Hodgkin's disease has also been known to have this blood picture.

It appears that intra-osseous disease accompanies this blood picture but the relationship is not known. It is not the result of displacement of hematogenous marrow because this is usually found in sufficient amount.

Three cases are presented in this article. Two patients showed a myelosclerosis with splenic enlargement, in one of whom x-ray therapy to the spleen hastened a fatal termination. None of the cases responded to liver therapy. The third case had widespread metastasis from a probable carcinoma of the prostate.

The hemograms show a low red cell count, color index of about 1, normoblasts, megaloblasts, eosinophilia, and often a basophilia.

J. B. McAneny, M.D.

Degenerative Leukocytic Transformations Associated with Aging: Differential Identification of Monocytes. Lowell A. Erf. Jour. Lab. and Clin. Med., **23**, 791–796, May, 1938.

In this study, various stages of degeneration of white blood cells were observed with the neutral red supra-vital technic. Vacuolar changes were outstanding and were so characteristic in the monocytes that they could be identified by following those changes alone.

A macrophagic stage was noted in various white cells during aging. This was taken to indicate a degenerative process rather than a transformation of one physiologic type to another.

W. A. Ward, M.D.

X-ray Treatment of Disorders of the Blood and Blood-forming Organs. H. F. Plaut. Jour. Med., **20**, 36–39, March, 1939.

In presenting this subject, the author states that the primary effect of irradiation is destruction of the blood cells, with the lymphocytes most sensitive to irradiation, the polymorphonuclears next, and the erythrocytes the most resistant.

Thrombocytopenic purpura of some types can be controlled by irradiation of the spleen. The result is often gratifying and obviates the necessity of splenectomy. Splenic irradiation is also of value in prolonged uterine bleeding and bleeding from surgical wounds of the nasopharynx.

Agranulocytosis, with its high mortality rate, has been favorably affected by irradiation. The result of irradiation is destruction of the leukocytes with the production of nucleic acid products which stimulate leukocytic production. Too heavy irradiation must not be used.

Secondary anemia is no contra-indication for irradiation and in many cases the anemia is often improved following irradiation.

In polycythemia vera, irradiation over the long bones will frequently cause a reduction in the number of red cells. The blood picture should be closely followed. Acute leukemias are not subjected to irradiation. Chronic myelogenous leukemia responds well to irradiation of the spleen and areas where the infiltrations produce pressure symptoms. In chronic lymphatic leukemia, the enlarged lymph node areas are irradiated, which, together with infiltrations of Hodgkin's disease, respond well to irradiation.

Lymphosarcoma is favorably affected by irradiation.

No dosage or technic is given in this presentation.

J. B. McAneny, M.D.

BLOOD PRESSURE

Results of Roentgen Therapy in Essential Hypertension. F. P. Boswell. South. Med. Jour., **31**, 1001–1003, September, 1938.

The author adds his experience to that obtained by others in the treatment of essential hypertension, and concludes that three out of four patients can expect symptomatic relief and a material drop in blood pressure.

X-ray therapy is applied to the pituitary and adrenals at weekly intervals—50 r being given for three treatments, 70 r thereafter, if there is no response. Treatments are continued until some benefit is obtained or until at least six have been given. Further treatments at intervals of several months are needed. Some

patients fail to respond at all; others are helped at first but unaffected by later treatments.

JOHN M. MILES, M.D.

BONE DISEASES (DIAGNOSIS)

Tuberculosis of the Long Bones: A Report of Six Cases. Frank C. Hodges. Jour. Bone and Joint Surg., **21,** 148–153, January, 1939.

This is a study of six cases of tuberculosis of the long bones seen during 1935–1937, inclusive. Sketches of the histories and courses of these cases are given.

It is found that lesions of the bones in patients with active pulmonary lesions give a bad prognosis for life. Progressive tuberculous bone lesions induce osteoporosis due to disuse and increased vascularity. If the reaction fails to produce increased vascularity because of local tissue reaction in defense of the invasion, the bone will become sclerotic. Biopsy and guinea pig inoculation should be made in cases of suspected bone tuberculosis.

JOHN B. MCANENY, M.D.

Discussion on Skeletal Changes in Metabolic and Endocrine Disorders. Proc. Royal Soc. Med., **31,** 1391–1404, October, 1938.

The article outlines too compactly for detailed abstracting the present knowledge of bone changes in metabolic, endocrine, and allied disorders.

Professor Henry Cohen discusses bone development; factors influencing growth and development, including endocrines, vitamins, diet, and general diseases as manifested by Harris' lines; various osseous changes accompanying endocrine dyscrasia; specific bone metabolism; the rachitic syndrome; metastatic deposits.

An unique case is recorded, characterized by gradual melting away of the bones of the hands between the ages of five and six years, following an apparently normal early life, followed by similar changes in the feet.

Dr. M. H. Jupe discusses roentgen changes under heads of disturbances of calcium content, disturbances of growth, and pressure manifestations.

Thyroid deficiency in endemic cretinism produces increased density in rather thick bands adjacent to epiphyseal lines.

RAY A. CARTER, M.D.

Leontiasis Ossea. Aleksander Lachowicz. Polski Przegl. Radiol., **13,** 79–85, 1938.

The author reports a case of leontiasis ossea observed in a four-year-old girl. The chief clinical symptoms were flattening of the nose, deformity of the facial features, and enlargement of the cranium. Roentgenologically, the manifestations consisted in extensive hyperostosis and sclerosis of all facial bones as well as of the parieto-occipital bones. The antra and the ethmoids were obliterated.

In the discussion of the disease, Lachowicz accepts the viewpoint that leontiasis ossea is no definite disease entity, but only signifies a clinical syndrome, the histological picture of which is identical with that of von Recklinghausen's and Paget's diseases. The etiology of the syndrome is obscure. The clinical course of leontiasis ossea varies within wide limits and may range from light and insignificant symptoms to fatal cases.

ERNST A. SCHMIDT, M.D.

A Case of Hydatid Cyst Primary in the Femur. Nicholas, Zwirn, and Penel. Bull. et mém. soc. de radiol. méd. de France, **26,** 350–353, May, 1938.

Radiographs of the femur of a women, 40 years of age, showed, in addition to a recent fracture, a markedly distorted architecture with multiple cystic areas and evidences of what appeared to be a chronic osteomyelitis. Pathologic studies after amputation revealed a generalized involvement of the bone and soft tissues, with hydatid disease. A fracture of the same femur 15 years before was probably a pathologic fracture through a cyst, which accounted for the dissemination of the disease.

S. R. BEATTY, M.D.

Paget's Disease of Bone: Its Frequency, Diagnosis, and Complications. James F. Brailsford. British Jour. Radiol., **11,** 507–532, August, 1938.

After a brief review of Paget's original article, a review of 54 cases observed by the author is given. The disease is about equally divided between the sexes. In some instances it appears to have a familial distribution. It is ordinarily seen after 40 years of age, but is occasionally seen in younger persons, the earliest case in this series occurring at the age of 27 years. This patient is described in detail, as it is also the earliest case observed. Examination revealed a cyst-like area in the tibial spine, and thick coarse trabeculations in the lateral femoral condyle. The cystic area in the tibia was curetted and the pathologic findings were those of chronic inflammation. Subsequent developments were typical of osteitis deformans, changes in other bones appearing later.

The disease is most commonly first seen in the pelvis on x-ray examination, though the tibia usually shows the changes first clinically. Changes are seen in the pelvis, tibia, femur, skull, spine, humerus, and os calcis in this order of frequency.

Fractures are a common complication. These heal readily. Pseudo-fractures, due to absorption of calcium, and possibly due to cracks following strain, are often seen on the convex border of bowed bones.

Malignant changes are often seen. Figures as high as an incidence of 40 per cent have been given, but in the author's series only six developed.

The etiology is still obscure Histologically the bones appear to have been absorbed and laid down afresh on a larger scale.

The first radiographic appearance is alteration of density in the bone. In the skull there are irregular areas of osteoporosis, thickening which may be irregular, areas of diffuse opacities, producing a woolly appearance. The inner table is as a rule clearly seen.

Patients who retain their teeth usually show dental caries.

The spine shows general thickening, and irregularity in density. Ossification of the ligaments is common. There is an exaggeration of the curvatures, resulting in the shortening of the height. The intervertebral spaces are preserved. Due to the softening of the bodies, these may show increased concavities on the upper and lower borders.

Similar bone changes are seen in the pelvis and long bones. Due to the softening, the weight-bearing causes deformity of the pelvis, with protrusion of the acetabulæ, and bowing of the long bones.

The disease must be differentiated from secondary carcinomatous invasion, chronic fluorosis, Albers-Schönberg disease, renal rickets type B, hyperostosis frontalis interna, chronic osteomyelitis, syphilitic osteitis, and endothelial myeloma. No known treatment alters the course of the disease.

S. J. Hawley, M.D.

Osteochondritis of the Adult Tarsal Navicular. James F. Brailsford. Jour. Bone and Joint Surg., **21,** 111-120, January, 1939.

Osteochondritis of the tarsal navicular in the adult differs from that of childhood in that it runs a more chronic course and leads to progressive deformity, a listhesis of the navicular, and is followed by arthritic changes.

Seven cases of this disease, all in women, are presented. Two other cases in men resemble more the characteristics of Kienböck's disease of the lunate.

With the listhesis of the navicular, the inner fragment glides over the head of the astragalus to its medial side and the outer fragment overrides the dorsal surface of the second and third cuneiforms, the cuneiforms sometimes approaching the head of the astragalus. Arthritic changes usually follow.

John B. McAneny, M.D.

Cleido-cranial Dysostosis. Witold Zawadowski. Polski Przegl. Radiol., **13,** 47–55, 1938.

A typical case of cleido-cranial dysostosis, with partial aplasia of the clavicles and cranial malformations, is presented. An unusual and hitherto unreported feature of the disease consisted in a marked hyperostosis of the wings of the sphenoid bone and of the adjoining portions of the squamæ of the temporal bones. In addition to the osseous changes, a congenital abnormality of the duodenum, with elongation of the upper portion, was noted.

Ernst A. Schmidt, M.D.

BONE DISEASES (THERAPY)

Generalized Decalcification of the Bones in a Case of Basedow's Disease. J. Ducuing and F. H. Colombies. Bull. et mém. soc. de radiol. méd. de France, **26,** 411–418, June, 1938.

A woman 53 years of age, suffering from hyperthyroidism which had responded poorly to medical and roentgen therapy, was examined radiologically to determine the cause of pain in the right hip. Roentgenograms of this region and of other bones of the skeleton, taken subsequently, demonstrated generalized areas of osteoporosis and pseudo-cyst formation. There was, in addition, a fissure fracture of the right femur and a tendency to thickening of the bones of the vault of the skull as well as osteoporosis.

Chemical studies of the blood revealed no changes consistent with hyperparathyroidism. The bone pain and other symptoms of hyperthyroidism responded fairly well to iodine and vitamin treatment, but the osteoporotic process continued to advance, involving new areas.

S. R. Beatty, M.D.

The Rational Treatment of Acute Hematogenous Osteomyelitis. J. Albert Key. Jour. Am. Med. Assn., **111,** 2163–2166, Dec. 10, 1938.

When a child suddenly becomes ill with fever and presents evidence of pain, disability, and localized deep tenderness in an extremity, osteomyelitis should be considered, and a negative x-ray examination does not rule out this disease. The disease is relatively frequent and not only carries a high mortality but usually causes prolonged illness in many of those who survive the acute attack and is an important factor in the production of crippling.

The disease is caused by pyogenic bacteria which enter the blood stream from some focus (demonstrable in about 20 per cent of the patients) or are present as causal organisms in the blood stream and localize in the bone and begin to multiply. More than 90 per cent of the cases that occur are in children, and it is generally believed that the usual site of the primary infection in the bone is in the metaphysis near the epiphyseal line.

In infants under two years of age, the offending organism is a hemolytic streptococcus in about half the cases and a staphylococcus in almost all of the remainder. In children over two years of age, about 90 per cent of the cases are due to *Staphylococcus aureus*, and the streptococci account for most of the remainder. Either of these organisms may kill the patient promptly by an overwhelming general infection, more slowly over a period of weeks, may lead to prolonged suppuration with necrosis of bone, or an abscess may form which drains and heals or which heals without drainage.

An increase in the patient's resistance or a decrease in the virulence of the organism will tend to cure the disease, and the converse also is true. Consequently, since "the first duty of the physician is to do no harm," care must be taken not to do anything to lower the patient's resistance even temporarily, unless sufficient benefit will accrue to justify the procedure. It is accepted that an operation tends to lower the patient's resistance temporarily and that the ill effects vary directly with the amount of blood lost, the extent of the

operation, the time consumed in performing it, and the duration of the period of anesthesia.

By the time the infection causes pain and local tenderness, the inflammation has spread through the cortex to the periosteum and early drainage of the focus in the bone is desirable in order to inhibit the spread of the infection in the bone and the resultant extensive necrosis of bone. Early drainage of the focus in the bone is desirable not only because it tends to limit the local spread of the infection in the bone but also because it tends to cut off the supply of organisms at its source.

Each patient must be considered as an individual problem which must be met according to the best principles of surgery.

The type of operation varies with the condition found and with the age of the patient. In infants, as little work as possible should be done on the bone. In children and adults, it is important that adequate drainage of the focus within the bone be accomplished.

CHARLES G. SUTHERLAND, M.D.

THE BRAIN

Congenital Anterior Herniations of the Brain. George F. Mood. Ann. Otol., Rhinol., and Laryngol., **47,** 391–401, June, 1938.

The author reports the case of a two-year-old girl who had a naso-ethmoidal hernia of the brain. Roentgen examination revealed a defect which suggested a mucocele of the right ethmoid sinus. At operation the tumor mass was found to extend into the cranial cavity and microscopic examination showed the tissue removed to be brain tissue. A review of anterior cerebral herniations with a summary of theories of pathogenesis is presented. A brief review of some twenty reported cases is given.

L. W. PAUL, M.D.

BRONCHIECTASIS

Bronchiectasis: A New Conception of its Etiology which Makes Prevention and Recovery Possible. Samuel H. Watson and Charles S. Kibler. Jour. Am. Med. Assn., **111,** 394, 395, July 30, 1938.

The fundamental basis for chronic or recurrent sinusitis is commonly an allergic rhinitis. Hansel found that almost half (44 per cent) of his patients seeking relief for nasal trouble were allergic and had abnormal amounts of eosinophils in their nasal secretions. The authors observed that patients with bronchiectasis frequently have hay fever, eczema, moderate but definite asthma at times, or other manifestations of clinical allergy. They found that in bronchiectasis the bronchial secretions had an abnormally high percentage of eosinophils; that is, 10 per cent or more. They then searched for other evidence of allergy and performed cutaneous tests. In fully 90 per cent of the cases of bronchiectasis, a definite diagnosis of allergy was made on the evidence found.

Seeing all stages of this condition from basal allergic bronchitis without bronchial dilatation to far-advanced bronchiectasis and noting that the great majority had accompanying manifestations of allergy made them feel that most bronchiectasis was caused primarily by basal allergic bronchitis. It is preventable, therefore, if the basal allergic bronchitis is recognized as such and given intensive treatment before bronchiectasis results. However, even after bronchiectasis has developed, the disease may be successfully combated if treated early. Improvement is in proportion to the advancement of the disease.

CHARLES G. SUTHERLAND, M.D.

CALCULI

Enormous Dilatation of a Gall Bladder Containing Calculi. Giraudoux, Phélip, and Dillenseger. Bull. et mém. soc. de radiol. méd. de France, **26,** 373, 374, May, 1938.

Radiographs of a woman with symptoms of an acute abdominal episode of clinically undetermined origin showed two calculi, one at the lower border of the liver, and one in the right iliac fossa. A laparotomy was performed and the two calculi were found in a greatly distended gall bladder (18 cm. long by 6 cm. in diameter). One calculus was impacted in the duct, the other, with which it had previously articulated, in the fundus.

S. R. BEATTY, M.D.

Ureteral Calculus: Clinical Analysis of 200 Cases. Colin A. Chisholm. Canadian Med. Assn. Jour., **40,** 380, 381, April, 1939.

The author presents a very interesting analysis of 200 cases of proved ureteral calculi. Roentgen findings were positive in 95 per cent, negative in 5 per cent. One-half of these patients presented symptoms which simulated gastro-intestinal or gynecological disease. When the diagnosis is doubtful, a roentgen examination should be an early procedure rather than a necessary afterthought.

M. L. CONNELLY, M.D.

Calcifications of Undetermined Origin in the Hepatic Region. R. Duranton. Bull. et mém. soc. de radiol. méd. de France, **26,** 366, 367, May, 1938.

In this case, cholecystograms showed two rounded calcific shadows above and to the right of the gall bladder which were supposed to be calculi in the hepatic duct. Ova of *Fasciola hepatica* were later found in the bile. The author believes the shadows may represent either calcified cysts in the liver or calculi formed around flukes.

S. R. BEATTY, M.D.

CANCER (DIAGNOSIS)

Perforation of Cancer of the Esophagus into the Trachea and Bronchi. André Cain, Roger Cattan, and

Henri Sikorav. Arch. d. mal. de l'app. digestif, **28,** 793–805, October, 1938.

Ordinarily, perforation of an esophageal carcinoma into the trachea or bronchus is followed rapidly by fatal pulmonary complications, but the authors report a case in which perforation was survived for six months, death resulting from pulmonary tuberculosis. Others report survivals of up to seven months.

In this case, the autopsy findings show the perforation occurred by direct extension into and destruction of the wall of the trachea.

Perforation of one of the contiguous structures is actually not common in carcinoma of the esophagus, as is generally believed. Carcinoma of the esophagus is usually a localized disease, massive involvement of the mediastinal structures being rare. An inflammatory reaction is usually present and tends to bind the mediastinal structures together, but plays only a secondary rôle.

S. R. Beatty, M.D.

Carcinoma of the Ampulla of Vater: Roentgenologic Demonstration. Samuel Brown and Archie Fine. Jour. Med., **20,** 76, 77, April, 1939.

In an examination of two cases of carcinoma of the ampulla of Vater, and the presentation of complete clinical records of the cases, it is discovered that there are very definite findings characteristic of this condition. In the descending loop of the duodenum, there is a sharply defined deformity without increase in the circumference of the loop. On the lateral and posterior walls of the descending loop, there is a sharply outlined filling defect.

John B. McAneny, M.D.

A Case of Perforation of the Diaphragm Combined with Gastro-pleural Fistula. A. Makower. Polski Przegl. Radiol., **13,** 99–102, 1938.

In a 62-year-old patient the x-ray examination revealed pyo-pneumothorax of the left side with ready passage of the gastric barium meal to the affected pleural cavity. The underlying pathologic change, *i.e.*, gastro-pleural fistula, was probably due to ulcerated carcinoma of the fornix of the stomach. The patient died within a few days after diagnosis but unfortunately no autopsy, which might have confirmed the clinical-radiological diagnosis, could be performed.

Ernst A. Schmidt, M.D.

The Incidence of Primary Bronchiogenic Carcinoma. Philip B. Matz. Jour. Am. Med. Assn., **111,** 2086–2092, Dec. 3, 1938.

Since primary bronchiogenic carcinoma has shown an increased incidence in recent years, the question arises as to the factors which have been responsible. Many observers attribute the increase to the epidemic of influenza in 1918–1919. On the other hand, cancer of the lung has never been reported in Iceland, where the ravages of influenza have been exceptionally severe. Industrial expansion, tarred roads, increased longevity, improvement of diagnostic methods, and a number of other factors were considered as causes of the increase.

A study of the autopsy material of the Veterans' Administration revealed that a definite increase in the incidence of carcinoma in general and of primary bronchiogenic carcinoma in particular had taken place. The statistical inference was that the increased incidence of primary bronchiogenic carcinoma was absolute. The question then arose as to what factors were responsible. Attention was focused on preceding diseases of the respiratory tract and it was found that 58.7 per cent of the cases had acute or chronic diseases of the respiratory tract of various types, either singly or in combinations, prior to the inception of the neoplasm. Further study revealed that 36 per cent of the patients had been engaged in occupations which were accompanied by exposure to irritation of the respiratory tract and traumatization of various kinds. The rise in incidence began when many of the veterans entered the cancer age period and it has continued since then.

Charles G. Sutherland, M.D.

Fundamental Cancer Research. Report of a Committee Appointed by the Surgeon General. Jour. Med., **19,** 612–617, February, 1939.

With the establishment of the National Cancer Institute, the Surgeon General appointed a committee to formulate the fundamental aspects of the cancer problem and to suggest appropriate avenues of approach to its solution.

The three lines of approach for analysis of this problem are: (1) biology of malignant cells as determined by transplantable tumors; (2) conditions governing the experimental induction of malignant tumors, and (3) the genetic factor in the development of cancer.

Once malignancy is established, it is a fixed characteristic of the cell, uninfluenced by other processes of the body function, and the cell maintains its characteristic of origin. The normal and malignant cell from the same structure fail to show any definite difference in structure, chemical make-up, enzyme content, metabolism, or law of transplantation. The present findings suggest that malignancy is the result of a fundamental change in cell physiology.

Many agents are known to initiate the development of a cancer. But it has not been shown that these agents must continue to be present for the maintenance of the growth. It appears that the agent only initiates a chain of events which later pass over into malignancy. Present evidence points to these carcinogenic agents as tending to inhibit cell growth rather than stimulate it. In the area of tissue disturbance, a new race of cells appears quite suddenly with no apparent gradation.

The Shope virus produces papillomas in rabbits, which growths later become cancerous but from which the virus can no longer be recovered although its presence is indicated indirectly by serological methods.

The hereditary factors in malignancy have been demonstrated by breeding experiments with mice,

in which a certain strain will produce a definite type of growth, while another strain shows a different type of growth. Castration, endocrine secretions, and irritation influence these malignancies. It has been shown that malignancy is a universal cell potentiality, which is variable in quality depending on hereditary factors and apparently independent of the inciting agent, once the malignancy is established. The property appears suddenly, is a fixed characteristic, and can be transmitted.

The research objectives in heredity suggest preventive measures and accentuate the effect of extrinsic agents. Heredity suggests the investigation of environmental and hereditary factors.

In the long list of carcinogenic agents, some common factor should be determined, and also what effect these agents have upon cells.

It is desired to know if the malignant cells become "fast" to conditions that normally control cell growth, or is there a break in the internal control mechanism, or is there a loss of body control of cell activity? These problems are fundamental in cancer research.

J. B. McAneny, M.D.

Cancer of the Small Intestine. J. M. Noothoven Van Goor. Arch. d. mal. de l'app. digestif, **28,** 820–829, October, 1938.

Cancer of the small intestine is a rare disease. The first meter of the jejunum and the terminal ileum are the sites of predilection. The clinical course is variable. Usually symptoms occur late and are those of stenosis or acute ileus. A tumor can remain undetected because the content of this part of the bowel is liquid and obstruction from food particles does not occur. Complete stenosis, hemorrhage, ulceration, or intussusception usually direct attention to the lesion.

These tumors are usually adenocarcinomas. Sarcoma occurs in only 1 per cent and benign tumors are rare. The prognosis is bad in most cases because of the late diagnosis. The treatment is surgical excision and anastomosis.

Two case reports are presented in this article. In one, an adenocarcinoma was found at the ostium of a diverticulum. The other case was particularly interesting because of an attendant macrocytic secondary anemia. This is not uncommon in organic lesions of the small intestine and may be due to inactivation of hematopoietic substance by abnormal secretions or by failure of absorption.

S. R. Beatty, M.D.

Cancer of the Ovary. Joe V. Meigs. New England Jour. Med., **220,** 545–551, March 30, 1939.

Meigs reviewed 250 cases of malignant ovarian tumors and for one good reason or another after critical examination, all but 147 cases were discarded.

Symptoms consist of abdominal enlargement, a feeling of weight, pain, urinary difficulty, and, at times, ascites. Half of the patients were between the ages of 30 and 50 years. Of the married women, only 63 per cent had had children. Abnormal vaginal bleeding after the menopause in the presence of a pelvic mass is suggestive of a malignant ovarian tumor.

Three types of tumors are recognized histologically: (1) pseudomucinous, with its high columnar cells containing pseudomucin; (2) papillary and solid forms that resemble endometrial epithelium, and (3) a mixed group composed of differentiated or undifferentiated cells. The criteria of malignancy were atypical cells, mitotic figures, invasion of the cyst wall, undifferentiation, and areas of adenocarcinoma.

Grossly they are classified as: solid, and solid and cystic, most serious, composed mostly of a solid mass and difficult to diagnose without operation; malignant papillary cystadenoma with areas of adenocarcinoma, of which pseudomucinous cysts are the least malignant and endothelial the most; malignant papillary cystadenoma which is less malignant than the two previous groups.

Surgery, early and radical, is the treatment of choice. Irradiation after surgery is advised but the results shown by the analysis do not favor this type of treatment as an exclusive agent. A hope is held that better planning of irradiation and more experience with high voltage will increase the number of five-year survivals.

Survival at five years shows the solid carcinoma 8 per cent, malignant papillary cystadenoma 26 per cent, with adenocarcinoma 16 per cent, and without adenocarcinoma 35 per cent.

John B. McAneny, M.D.

CANCER (THERAPY)

Preliminary Results in Near-distance Roentgen Therapy of Surgically Exposed Carcinoma of the Rectum. H. Chaoul. Strahlentherapie, **64,** 219, 1939.

The author describes briefly the operative technic used in exposing a carcinoma of the rectum before applying x-ray therapy, at close range, with massive doses. The technic is as follows: 60 kv., 0.2 mm. Cu, daily doses of 500 r with from 150 to 200 r/min. The treatment is continued until the tumor has completely disappeared. The doses required vary between 12,000 and 15,000 r. As soon as the radiation reaction has entirely subsided, the parts of the intestines which were involved by tumor are resected and the colostomy, performed previous to the exposure of the tumor, is closed. So far, 23 cases have been subjected to the treatment. Three were borderline, 18 inoperable, and two hopeless. Fourteen were free from symptoms at the time of this report and nine were not cured. The periods of observation were four years (2), three years (1), two years (3), one year (2), up to one year (6).

Ernst A. Pohle, M.D., Ph.D.

Cancer of the Pillars of the Soft Palate Cured for Almost Ten Years by Radiotherapy: Report of Case. P. Dufour and C. Armand. Bull. et mém. soc. de radiol. méd. de France, **26,** 367, 368, May, 1938.

A cancer of the soft palate was cured after three

series of roentgen-ray treatments: 3,000 R (Solomon) given to each of two lateral and one posterior portals, 1 cm. Al filter, given in ten days. The necessity for continued observation and treatment is illustrated by the course of this case.

S. R. Beatty, M.D.

Complications in the Rectum in Patients with Carcinoma of the Uterus. F. Gal. Strahlentherapie, **64**, 125, 1939.

Following irradiation of the pelvis, especially in patients with carcinoma of the uterus, bloody stools are frequently seen. They may be due to reaction of the mucosa or an extension of the carcinomatous process into the rectum. An analysis of the author's material revealed the fact that among 2,320 cases treated during the last 15 years, by x-rays or radium, for carcinoma of the uterus, in 13 instances bleeding from the rectum was due to carcinoma and in eight it was due to inflammatory changes in the mucosa. In 11 cases the lesion causing the bleeding developed after complete regression of the uterine tumor. The essential data on all cases are given in a table, while brief histories of two patients with secondary carcinoma of the rectum, cured for 10 and 13 years, respectively, are appended. It is very important to establish the differential diagnosis between radiation reaction and metastatic carcinoma because of the entirely different therapeutic approach in each case.

Ernst A. Pohle, M.D., Ph.D.

Abdominal Tetanus Occurring Fifteen Days after Vaginal Curie Therapy. Vincent Paschetta. Bull. et mém. soc. de radiol. méd. de France, **26**, 342, 343, May, 1938.

A patient who had previously been treated by roentgen therapy and electrocoagulation for a vaginal carcinoma recurrent following hysterectomy, was treated intravaginally with two 10 mg. tubes of radium over a period of seven days. Fifteen days after removal of the radium, the patient developed tetanus and died within a few days. The author believes that the massive dose of radium stirred up a pre-existing infection. He advocates the clearing up of all infection before undertaking surgical or radiologic procedures in carcinoma of the uterus or vagina.

S. R. Beatty, M.D.

COLITIS

The Medical Management of Chronic Ulcerative Colitis. Thomas T. Mackie. Jour. Am. Med. Assn., **111**, 2071–2076, Dec. 3, 1938.

The prolonged observation in this series of cases, together with isolated observations from many others, points to the probability that ulcerative colitis is a chronic disease with an inherent tendency to progression and relapse. It is characterized pathologically by inflammation and progressive production of scar tissue in the deeper layers of the colonic wall. It is characterized physiologically by secretory and motor disturbances of the stomach, the small intestines, and the colon, and at times by disturbed function of other physiologic systems. It appears to result from the action of several different factors operating singly or in conjunction with one another. These include primary infection, which present evidence indicates may be produced by several known pathogenic organisms; secondary infection especially by *Escherichia coli* and *Streptococcus fæcalis;* sensitization of the colon to foreign protein of food and bacterial origin, and secondary or conditioned deficiency disease. Successful medical treatment is based on the evaluation and control of these factors. Prognosis depends in part on this and in part on the degree of permanent damage to the colon. Radical surgery should be seriously considered in those cases which fail to respond to conservative treatment, in those which exhibit the effects of chronic sepsis, and early in those which present the proximal type of pathologic change.

Charles G. Sutherland, M.D.

The Surgical Treatment of Ulcerative Colitis. Thomas E. Jones. Jour. Am. Med. Assn., **111**, 2076–2078, Dec. 3, 1938.

With ulcerative colitis, the surgeon and the medical man must learn to speak the same language and the question should not be surgery *versus* medical management of ulcerative colitis but a wise combination of the two. All authorities agree that certain complications of this disease constitute definite indications for surgery, such as the presence of stricture, polyposis or neoplasm, perirectal abscess, and regional or right-sided ulcerative colitis. These remarks pertained to the so-called universal type (93 per cent of cases at the Cleveland Clinic) wherein the disease starts in the rectum and extends in an upward direction in the colon.

One factor that contributes to some delay in surgical treatment arises when some new form of therapy is advocated and a trial of it is desired in the hope that it will be specific.

In the acute fulminating form, acute or subacute perforations may occur and operative treatment does not have much to offer. Medical management should be employed for this type of case for three or four weeks and, if improvement has not followed, ileostomy should be considered. More careful attention to the blood chemistry, which has not been stressed in the past, may materially lower the mortality in the future. The mild cases probably are best handled medically because these patients may go for 10, 15, or 20 years with little or no inconvenience and are able to carry on their daily duties.

The moderately severe cases, however, comprise the great majority and it is in this group that we are most interested. The frequent recurrences which last weeks or months are often associated with considerable disability and make the patient unproductive because he must constantly take time off from his work and, therefore, no one wants to employ him. His impulse is to resort to surgery while there is a possibility

of doing a colostomy instead of waiting until an ileostomy is required.

Operations which have been employed are cecostomy, appendicostomy, ileostomy, and colostomy with or without colectomy later. There is not sufficient evidence that appendicostomy or cecostomy for irrigative purposes in themselves are curative, even though it is granted that they do produce some improvement and make the patient somewhat more comfortable. The primary purpose of surgery is to divert the fecal stream and put the bowel completely at rest and free from infection. This must be done by ileostomy or colostomy.

Close scrutiny of many cases reported as failures will reveal that a colostomy was improperly located or improperly done. It is necessary to place the colostomy at considerable distance proximal to the diseased colon and, if the sigmoid is at all involved, it must be done in the transverse colon. It is also wise not to make the loop colostomy but to divide the bowel and its mesentery for some distance so as to try to obviate jumping over of the infection. The author believed irrigation of the distal loop had a distinct value and could not be duplicated by enemas without colostomy.

If the disease has begun to invade the transverse colon, or if there is no improvement after adequate medical treatment, ileostomy is advisable early rather than late. If the entire colon is involved and the patient does not respond to medical management, ileostomy becomes imperative and the condition of the patient decides the optimal time. The future course depends entirely on the convalescence of the patient. If he still seems toxic and does not gain weight, colectomy is indicated.

Charles G. Sutherland, M.D.

Prognosis of Ulcerative Colitis. J. H. Willard, J. F. Pessel, J. W. Hundley, and H. L. Bockus. Jour. Am. Med. Assn., **111,** 2078–2084, Dec. 3, 1938.

Sixty-six patients were selected for study. Extreme care was used to exclude all cases which did not exhibit the typical picture of so-called idiopathic ulcerative colitis in one of its various stages. The primary requisite was diffuse involvement of the mucosa of the rectum and sigmoid. Cases presenting isolated ulcerations or patchy involvement were not accepted. Cases of right-sided colitis, regional colitis, ileocolitis or regional ileitis, or proved venereal lymphogranuloma were not included. The estimation of final results in the series was based on actual examination of the rectal mucosa in 80 per cent of the cases and only those patients who had been symptom-free for one year and who showed no sigmoidoscopic evidence of activity were reported as being in remission.

These writers believe that the type of colitis discussed in their series is a clinical entity, and that it corresponds to the disease described by Bargen as "thrombo-ulcerative colitis." However, the bacteriological studies on these cases failed to indicate a specific etiology for the disease.

The serious nature of ulcerative colitis was indicated by the mortality and morbidity figures both in the literature and in their series. In general, the methods of treatment seem to have little effect on the statistics, although the use of multiple procedures made definite conclusions impossible. It was the experience of these investigators that no single therapeutic measure had produced striking results in more than an occasional patient. Some patients responded well to one procedure during one relapse and to another procedure during a subsequent relapse. The entire armamentarium frequently failed to produce favorable results. Surgical intervention was one of the factors resulting in a higher mortality rate. The non-operative mortality rate was not appreciably altered by the adoption of a more conservative plan.

The acuteness of the infection and the resistance of the patient are obviously important factors prognostically. In this series, the highest mortality rate appeared in those patients with short histories. This is probably due to the inclusion of a large number of cases of acute fulminating disease. Patients with mild symptoms of short duration clearly offer the best prognosis, but many of these seen prior to three years before were not included in this series because of lack of follow-up data. The greatest number of deaths occurred in those having had the disease for six months or less. In most of the fatal cases, the disease had an acute febrile, toxic, or fulminating course. The patients whose disease had lasted from seven months to a year showed a lower rate of mortality and a greater incidence of improvement or remission.

The x-ray appearance of the colon was not a reliable prognostic guide.

Charles G. Sutherland, M.D.

THE COLON

Dolichocolon and Painful Abdominal Crises. Claude R. Bocca. Jour. de méd. de Lyon, **19,** 507–521, Sept. 5, 1938.

The diagnosis of dolichocolon is made radiologically. The clinical significance of this type of colon has been minimized by many; others recognize it to be the source of clinical symptoms such as constipation, ærocoli, and painful abdominal crises of characteristic types. These crises may be of three types: (1) extra colonic, dyspeptic, hepato-biliary, ilio-cecal, etc., (2) colitis, and (3) crises of partial obstruction, repeated, generally relieved spontaneously.

Abdominal pain is frequently the first intimation of trouble with a dolichocolon previously asymptomatic.

The treatment is primarily medical—diet, re-education of intestinal habits, antispasmodics. The use of enemas is debatable. Surgical intervention is sometimes required.

S. R. Beatty, M.D.

Surgery of the Colon. Harvey B. Stone. Pennsylvania Med. Jour., **42,** 105–108, November, 1938.

Colitis and diverticulitis, their diagnosis and treatment, are briefly discussed by the author, who states

that a barium enema is of great help in the diagnosis of chronic diverticulitis, but its use in the acute stage is dangerous.

The diagnostic problems of early carcinoma of the colon are thoroughly discussed. Barium by mouth is not thought to be a satisfactory procedure; a barium enema, however, will show the presence of carcinoma with a high degree of accuracy. The author's experience has shown that some filling defects have been misdiagnosed and early carcinomas have been overlooked by this method, to be found later at operation.

The author states that radiation therapy "is not regarded as useful" in carcinoma of the colon.

JOSEPH T. DANZER, M.D.

Functional or Sociologic Disorders of the Colon. E. G. Wakefield and Charles W. Mayo. Jour. Am. Med. Assn., **111**, 1627–1632, Oct. 29, 1938.

Persons who have a functional disorder of the colon which may have been excited by social conditions describe symptoms which they believe arise in the colon, but when the colon is examined it is found to be free of physical changes which are indicative of organic disease. This disorder is manifested by irregularities of defecation and apparent alteration in the absorptive and secretory functions of the colon. It frequently is associated with abdominal discomfort, pain, and often with mucus in the feces and subjective abdominal distention. Changes in symptoms, which are the rule, may be related to changes in the quantity of mucus present in the feces. Alternating periods of constipation and diarrhea are not uncommon, but the outstanding symptom usually is either diarrhea or constipation.

If the exciting etiologic factor is intellectual and emotional weakness, one must show the patient his personal responsibility instead of resorting to the administration of placebos. If the symptoms are due to unsuitable moral or religious tendencies or are the result of erroneous interpretations of defectiveness, disease, or supposed misconduct of the colon, recovery may be attained only through mutual responsibility. The patient's confidence from the beginning is, therefore, of the utmost importance.

The possibility of systemic disease must be considered in every case of functional disorder of the colon. Deficiency diseases, such as pellagra and sprue, must not be overlooked. Pernicious anemia with the associated achlorhydria, and chronic poisoning by lead and other heavy metals, exophthalmic goiter or Addison's disease, all may be accompanied by intestinal symptoms which may be most difficult and which usually require careful study. Fevers, infectious disease, septicemia, malnutrition from any cause, pelvic and abdominal tumors, and deranged functions of the pancreas, liver, and kidneys are at times accompanied by colonic symptoms to such a degree that the underlying cause is masked. Suggestion may be the basis for initiating a symptom. Environmental changes create social crises which are important etiologic factors in functional disorders. Those who are fearful of disease of the colon are constantly tantalized by advertisements; at least an air of sympathy and a thorough examination are required as a beginning to convince the patient that there is no evidence of organic disease. Those who are intelligent and who have a good, sound basis for their fear, such as an unexplained diarrhea following a recent pulmonary tuberculosis or time spent in a tropical climate, are temporarily maladjusted and will recover if proper advice is given by the physician. The patient whose judgment is fallacious is difficult, if not impossible, to treat successfully. The habitual user of purgatives punishes the colon because of erroneous ideas of its proper function. It has been the experience of all careful observers that congenital malformations do not produce symptoms that are as indefinite and as obscure as those often present in a functional disorder. They do not believe that the erect position of man produces digestive handicaps.

Those who are too sympathetic toward the idea of food allergy vision an allergy to some food in every case of indefinite abdominal symptoms. Many vicious habits of eating, sleeping, defecation, and work are absolutely unrecognized by the patient. These can be ascertained only by taking a detailed clinical history. At birth, one either possesses the type of nervous system of the stoic or that of the "nervous" irritable person. Environment with its harmful or beneficial influences yields what the physician has to work with.

Organic disease is likely to be ushered in with fever, loss of weight, and perhaps blood in the stool. A functional disease arises during or following the stress and strain of a social crisis. When the symptoms are intermittent, exacerbations come during subsequent crises. In some cases, when the environment has not changed the symptoms become constant. The symptoms of organic disease are likely to be progressive or cease to exist. It is important to remember that organic disease may co-exist or be superimposed on a functional disorder of the colon.

The diagnosis of a functional disorder of the colon depends on the following criteria: (1) Three specimens of fresh liquid feces obtained, if necessary, by the administration of saline purgatives should not contain ova or parasites. (2) Proctoscopic and sigmoidoscopic examination should reveal a normal mucosa and normal mobility of the bowel. (3) Roentgenologic examination of the colon and terminal portion of the ileum by means of an opaque enema, after adequate preparation, should not disclose any abnormality (if the ileocecal segment of the bowel is not visualized, it may be necessary to administer the opaque medium orally). (4) Free hydrochloric acid should be present in the gastric contents after administration of a test meal. (5) The basal metabolic rate should be within normal limits. The last two of these examinations are not necessarily routine. The judgment of the examiner must be relied on in determining the necessity for further examinations to rule out endocrine disturbances, just as the necessity of

other special tests, such as cutaneous tests for possible allergy, and examinations of the blood and urine for detection of possible poisoning with heavy metals. That is, the diagnosis is made by the process of elimination.

In phases of constipation, the only laxative which should be used is one that acts by forming a non-irritating bulk. Crude or flake agar in doses of from one to four ounces (30 to 120 gm.), administered in cereal or milk, is the most reliable.

The success of treatment of diarrhea depends on acquainting the patient with his reactions and the effects of a social crisis. The patient should be made to understand that the colonic discomforts are reflex phenomena and not the result of organic disease, and a regimen established which is aimed toward physical rehabilitation.

CHARLES G. SUTHERLAND, M.D.

Diverticula of the Cecum and Ascending Colon. G. Ronneaux. Bull. et mém. soc. de radiol. méd. de France, **26,** 324–328, May, 1938.

Diverticula of the cecum and ascending colon are rare. This region is usually free, even in cases of multiple diverticulosis. Frequently retrocecal, the lateral or oblique view is necessarily employed to demonstrate them or exclude the diagnosis. Palpation of this region during the fluoroscopic examination will help to fill the diverticula, which are often occluded by fecal material.

S. R. BEATTY, M.D.

THE CRANIUM

Some Cranial Changes in Recklinghausen's Neurofibromatosis. Thomas Rosendal. Acta Radiol., **19,** 373–390, October, 1938.

In eight patients suffering from Recklinghausen's neurofibromatosis the following cranial changes were observed by the author: dilatation of the optic foramina combined with oligodendroma of the optic chiasma in two cases; abnormal vascular design of the cranium combined with sellar depression and arachnoiditis in one case; unilateral secondary atrophic cranial changes combined with facial hypertrophy in one case; unilateral enlargement of the orbit, the middle cranial fossa, and the sella turcica in two cases.

The different theories concerning the pathogenesis of the disease are discussed in detail.

ERNST A. SCHMIDT, M.D.

Intracranial Cysts. Adams A. McConnell and S. J. Douglas. Irish Jour. Med. Sci., **158,** 66–72, February, 1939.

The authors present three cases of subarachnoid cysts and one case of subdural cyst. The histories and clinical findings were typical of space-filling intracranial lesions and were demonstrated by radiographs, some of which are reproduced.

No cause for the occurrence of the cysts is demonstrated. The subarachnoid cysts are believed to result from a previous adhesive arachnoiditis, but no new evidence is offered for this belief.

As fluid accumulations are frequently found between the dura and arachnoid subsequent to head injuries, it is believed that many subdural cysts result from an unabsorbed subdural hemorrhage following a head injury.

JOHN B. MCANENY, M.D.

CYSTICERCUS

Radiological Picture of Non-calcified Cysticercus in Muscles. Ugo Garretto. Radiol. Med., **35,** August, 1938.

The author reports what he claims to be the first roentgenological study of a case of non-calcified cysticercus embedded in the soft tissue.

The patient, a ten-year-old girl, presented upon examination multiple small subcutaneous nodules that suggested the diagnosis. Radiograms, made with the same technic used to demonstrate the calcified larvæ, were negative. A biopsy, however, showed the cysts and confirmed the diagnosis. It is evident that anyone using this technic would have had the same negative result. It was then decided to use a soft-tissue technic such as that used for the visualization of muscles. It is as follows: 45 kv., 30 ma., at a distance of 1 meter, for from three to six seconds (Meldolesi and Garretto).

A roentgenogram made with this soft-tissue technic showed the lesions to be widely scattered in the soft tissue, and to present the following characteristics: The cysts were numerous, and evenly distributed throughout the muscles; they were rounded, of a rather uniform size, from 1 to 3 mm. in diameter, of irregular, uneven borders that gradually blended into the muscular shadow. A few of the individual lesions were elliptical while others appeared to be confluent. In certain places the cysts overlapped each other and cast a shadow like the links of a chain. On the average, one square centimeter contained from six to seven cysts.

The patient also presented certain gastric disturbances attributable to the presence of the tænia in the gastro-intestinal tube.

ANTONIO MAYORAL, M.D.

THE DIAPHRAGM

The Differential X-ray Diagnosis between Pleuritis and Empyema: Some Important Clinical Data. Sten Oldberg. Acta Radiol., **19,** 337–347, October, 1938.

Emphasizing the importance of the behavior of the diaphragm in affections of the pleura, the author discusses the different factors which normally influence the position and function of the diaphragm. The observation of the diaphragm aids materially in the differential diagnosis between serous pleuritis and septic

empyema. A sufficient quantity of serous exudate causes a flattening and depression of the diaphragmatic cupola, while it increases the respiratory movement of the mediastinum. On the other hand, in septic empyema the respiratory movements of the mediastinum are reduced and the diaphragm is markedly elevated (chiefly due to paresis of the diaphragm). Serous exudates usually show the typical concave border, with regard to the lung, while empyema becomes encapsulated and presents irregular or bulging contours.

The author reports three cases which illustrate the importance of high paracentesis whenever empyema is suspected.

Ernst A. Schmidt, M.D.

A Case of Diaphragmatic Deformity (Probable Partial Eventration). Aubry and Bertrand-Guy. Bull. et mém. soc. de radiol. méd. de France, **26,** 177–179, March, 1938.

Discussing the diagnosis of a peculiar cone-shaped shadow projecting above the left diaphragm, the authors suggest the diagnosis of a partial eventration.

S. R. Beatty, M.D.

DOSAGE

The Existence of a Critical Intensity. W. H. Love. British Jour. Radiol., **11,** 686–700, October, 1938.

This article is a mathematical analysis of the results of several workers based upon the following hypotheses: (1) that a cell has a stage in its life cycle during which it is particularly susceptible to radiation; (2) the effect of radiation on whole tissue depends principally upon doses received by individual cells as they pass through the sensitive stage, and (3) the shape of the curve relating dosage and fractional biological effect is usually sigmoid.

The analysis shows that for any irradiated tissue, the biological effect of a predetermined dose will be greatest for some particular value of intensity. Factors which determine the existence of a critical intensity are defined. The relation between the critical intensity and dose is discussed, and the application of efficiency curves to radiation therapy is considered.

S. J. Hawley, M.D.

Depth Doses from Teleradium Units. W. V. Mayneord and J. Honeyburne. British Jour. Radiol., **11,** 741–754, November, 1938.

A unit for teleradium measurement is described in which the focal distance, thickness of filter, and area of the source can be varied. The measuring device is described. It was found that the amount of soft radiation at the aperture of the radium source increased with the distance as does the percentage depth dose. Curves and tables are given, showing the details of the changes with various conditions. The introduction of 0.5 mm. of lead and 0.6 mm. of brass produced the greatest improvement in depth dose. Varying the area of the source produces little change in the depth dose for large distances. For short distances, enlarging the source increases the depth dose up to about 20 per cent. The inverse square law does not accurately predict the depth dose.

S. J. Hawley, M.D.

ENCEPHALOGRAPHY

Encephalography with Small Quantities of Air (Laruelle). M. Weinbren. British Jour. Radiol., **11,** 705–725, November, 1938.

Laruelle, of Brussels, first reported the base-line method of encephalography, in 1929. The author reports the results of the use of this method in cerebral tumors, post-traumatic cases, and epilepsy. While it is of great value, it does not replace routine encephalography and ventriculography. The method is so simple and is attended with so few dangers that it has been found to be worth while.

The three superior ventricles are placed with mathematical accuracy in relation to the sagittal plane, and to a base line drawn across the upper edges of the orbits. To determine this relation or displacements from it, it is necessary only to inject 5 c.c. of air, and occasionally 10 c.c., but no more. The technic is simple. The usual lumbar puncture is done with the patient sitting at the radiographic machine, 10 c.c. of fluid allowed to drop away, and 5 c.c. of air injected slowly. The patient's neck must not be flexed at too great an angle or the air will not enter the ventricle. The first film is made from three to five minutes after injection. If the injection has been successful, the needle is withdrawn; if not, from three to five c.c. more are introduced. Films are made of various views of the skull with the patient erect and horizontal. While the method will not always give complete information, it is so simple that it is particularly useful as a scout procedure, and is satisfactory to identify normal states. A number of excellent illustrations are included in the article.

S. J. Hawley, M.D.

ENDOCRINOLOGY

Radiotherapy of the Nerves in Endocrinology. J. A. Huet. Bull. et mém. soc. de radiol. méd. de France, **26,** 205, 206, April, 1938.

From his experience in the treatment of glandular disturbances, the author concludes that more important than treatment of the gland itself is treatment directed to the nervous supply of the gland. This theory has been applied with uniform results in a series of 400 cases of endocrinopathies.

In early cases, treatment of the peripheral nerves and glands with doses of from 30 to 50 r per séance and per field (120 kv., 3 mm. Al), to totals of from 300 to 400 r suffices. In older cases, in addition, therapy directed to the medullary relays with increased dosage and penetration, *e.g.*, from 100 to 250 r per séance per field, 100–125 kv., 8 mm. Al, to a total of from 1,000 to 1,500

r is required. In long standing cases, the hypophyseal region should receive from 1,500 to 3,000 r given through six portals, 450 r per séance, 200–250 kv., 1 mm. Cu + 2 mm. Al.

Each case should be individualized, the diagnosis properly established, and the optimum time for radiologic treatment carefully observed.

S. R. Bbatty, M.D.

THE ESOPHAGUS

Acute Esophagitis. Belinoff. Bull. et mém. soc. de radiol. méd. de France, **26,** 617, 618, October, 1938.

Painful dysphagias may succeed acute infectious diseases, especially influenza. These are apparently due to myositis or neuritis of toxic origin. Radiologically, there is evidence of marked delay in the passage of the meal due to esophageal dysfunction or spasm.

S. R. Beatty, M.D.

Diagnosis of Paralysis of the Esophagus. Pierre Mounier-Kuhn. Bull. et mém. soc. de radiol. méd. de France, **26,** 601–606, October, 1938.

The diagnosis of esophageal paralysis is infrequently made. The author has observed four cases. It is often associated with laryngeal and hypopharyngeal paralysis and is due usually to diphtheria, polioencephalitis, or the lesions which may affect the medulla.

Severe dysphagia, especially for non-liquid foods, is the cardinal symptom. This is due in part to the associated paralysis of the inferior constrictors. There is a sensation of retrosternal fullness and even pain, accompanied at times by faintness. Food passes through the cardia only by gravity and swallowing in the reclining position becomes impossible. There is no vomiting or regurgitation and induced vomiting is impossible. Dietary restriction and weight loss of serious degree follow.

When examined radioscopically, one notes atony and a lack of peristaltic action. Liquids seem to fall directly into the stomach; pasty or solid foods are arrested for considerable lengths of time.

The finding of the associated pharyngeal and laryngeal paralyses and the radioscopic findings make the diagnosis definite. The importance of the diagnosis rests in the necessity for early resort to liquid diets sufficient to maintain nutrition.

S. R. Beatty, M.D.

Aneurysm of the Transverse Aorta and Esophagocardiospasm, with Mega-esophagus. J. Monges and J. Olmer. Bull. et mém. soc. de radiol. méd. de France, **26,** 606–613, October, 1938.

It is the opinion of the authors that the association of symptoms of esophageal stenosis with aortic aneurysm is rarely due to compression of the esophagus by aneurysm but, rather, to irritation of the pneumogastric plexus by peri-aortitis. This gives rise to spasm of the lower portion of the esophagus and cardia and eventuates in the formation of mega-esophagus. In this article two cases are presented in detail to demonstrate the validity of this theory. In neither case was there evidence of compression by aneurysm but in both cases there was marked narrowing of the lower portion of the esophagus with dilatation above this region. In one case death occurred as a result of starvation; in both cases the chief symptoms were due to esophagospasm and mega-esophagus.

Esophagoscopy and dilatation may be dangerous in the presence of aneurysm. Atropine proved of benefit in these cases. Gastrostomy is the one surgical procedure which may be considered, if necessary to prevent starvation.

S. R. Beatty, M.D.

Diverticulum of the Esophagus. Gleize-Rambal and P. Ducellier. Bull. et mém. soc. de radiol. méd. de France, **26,** 616, 617, October, 1938.

It is frequently necessary to employ several projections to demonstrate the presence of diverticulum of the esophagus. To illustrate this requirement, the authors present the case of a man 93 years of age with a diverticulum of the lower portion of the esophagus.

S. R. Beatty, M.D.

Two Cases of Tracheo-esophageal Fistula, Following Unsuspected Esophageal Carcinoma. H. Duclos. Bull. et mém. soc. de radiol. méd. de France, **26,** 614, 615, October, 1938.

Two cases of tracheo-esophageal carcinoma are presented. One developed symptoms of fistula while under treatment for cervical nodes—in retrospect, metastatic from the esophageal carcinoma. In the other case, acute dysphagia was the occasion for the examination which revealed the fistula.

Esophageal carcinoma may remain symptomless until far advanced.

S. R. Beatty, M.D.

GASTRO-INTESTINAL TRACT (DIAGNOSIS)

The Roentgen Diagnosis of Diseases of the Ileocecal Region of the Gastro-intestinal Tract. Joseph Jellen. California and West. Med., **50,** 188–190, March, 1939.

This is a very excellent review on the various diseases which affect the ileocecal region, the author having discussed the roentgenological findings of the many diseases which occur in this area. The article illustrates the importance of thorough study of the terminal ileum, particularly in the patient's unexplainable right lower abdominal pain.

James J. Clark, M.D.

Usefulness of Atropine Paralysis in the Examination of the Gastro-intestinal Tract. A. Bernard and H. Monnier. Arch. d. mal. de l'app. digestif, **28,** 806–812, October, 1938.

The injection of atropine, following preliminary radiologic studies of the gastro-intestinal tract, causes paralysis and allows dilatation of the stomach, pylorus,

duodenum, jejunum, and colon. Passage of barium is delayed and better definition of the organs is possible.

The parietal lesions—neoplasm, ulcer, perigastritis—are not influenced by atropine and the absence of paralysis of a segment indicates an organic lesion. The disappearance of deformities after atropine is evidence that they are due to spasm. The relaxation of uninvolved portions increases the visibility of neoplastic lesions, gastric and duodenal deformities.

Employing the doses used by the authors (1.5 mg.), the method is without danger and should be more frequently employed.

S. R. BEATTY, M.D.

The Training of the Gastro-enterologic Internist. H. L. Bockus. Jour. Am. Med. Assn., **111**, 1145–1148, Sept. 24, 1938.

This was the chairman's address before the Section on Gastro-enterology and Proctology at the Eighty-ninth Session of the American Medical Association.

The gastro-enterologic neophyte in order that he may qualify as a specialist should first of all obtain basic training in internal medicine by one of the many plans which are available. Musser mentioned five: (1) university fellowship, (2) clinic fellowship, (3) hospital residency, (4) preceptorship, and (5) formal graduate training. No matter which plan is employed, the objective must be sufficient training in internal medicine to meet the requirements for certification by the American Board. His training should be sufficiently comprehensive so that he may be considered to have a working knowledge of (1) clinical gastro-enterology, (2) neuropsychiatry, (3) endocrinology, (4) allergy, (5) nutrition, (6) physiologic chemistry of the digestive tract, (7) diagnostic roentgenology of the digestive tract, and (8) certain endoscopic examinations. The first five topics are divisions of internal medicine, and basic training in each of them will be acquired during the period of preparation for certification in internal medicine.

In a discussion of each of these topics under separate headings, the essayist stated: "The intelligent application of fluoroscopy and roentgenography constitutes the most valuable aid in the diagnosis of motor dysfunction and of organic disease of the alimentary tract. The neophyte will obtain ideal training by associating himself with a roentgenologic expert in gastro-intestinal diagnosis who is working in close collaboration with a gastro-enterologic expert in film interpretation. The application of the roentgen diagnosis to clinical problems is the duty of the internist. He alone can muster all the pertinent diagnostic data and should be capable of expert interpretation of the roentgen appearances."

With the introduction of the flexible Wolf-Schindler gastroscope, it becomes possible to diagnose more accurately certain diseases of the gastric mucosa. There can be no doubt of the value of this examination in some cases and it should become the most reliable if not the only accurate method of diagnosis of gastritis. The gastro-enterologic student should receive training in the use of the gastroscope and be alert to its possibilities, bearing in mind that it is a rather uncomfortable experience for most patients to undergo and consequently that it should be utilized only when definite indications are present. The lower 10 inches of the intestine can be rather easily inspected with a sigmoidoscope of narrow lumen. Lesions in this region can be diagnosed with certainty by its use. Every patient with symptoms referable to the colon should be subjected to sigmoidoscopy, and every gastro-enterologist should be an expert sigmoidoscopist.

CHARLES G. SUTHERLAND, M.D.

Regional Enteritis. William A. R. Chapin. New England Jour. Med., **220**, 232–235, Feb. 9, 1939.

This review of the literature on "regional enteritis," "regional ileitis," or "terminal ileitis," as the choice of name may be, accentuates the fact that it is most commonly found in Jewish patients and rarely in Irish patients.

The symptomatology is most variable and a misdiagnosis is common, confusion especially occurring with appendicitis, as might be expected. The usual findings are pain in the right lower quadrant, fever, leukocytosis, anemia, and abdominal mass. The not uncommon formation of fistulæ should be considered when a diagnosis of cecal tuberculosis is about to be made.

With the present frequency of x-ray examination by barium meal and enema, many of these cases are distinguished and properly diagnosed pre-operatively.

Five case reports are added to the literature.

J. B. MCANENY, M.D.

A Case of Carcinoma of the Cecum Causing Intussusception, with Special Reference to the Roentgenological Features. A. G. G. Melville. British Jour. Radiol., **11**, 649–656, October, 1938.

A case history of a patient with carcinoma of the cecum causing intussusception is given. The roentgen-ray findings were a shortening of the cecum and ascending colon and a narrowing of the terminal ileum. The ileum could be seen invaginating itself into the colon. A brief review of the literature is given, illustrating the various appearances that intussusception may give.

S. J. HAWLEY, M.D.

Ilio-ilio-colic Intussusception in an Infant: Diagnostic and Prognostic Value of the Opaque Enema. A. P. Lachapèle. Bull. et mém. soc. de radiol. méd. de France, **26**, 424–426, June, 1938.

Presenting the report of a case of ilio-ilio-colic intussusception, the author comments on the differential diagnosis of the various types of intussusception of the ilio-colic region. The diagnosis of the ilio-ilio-colic type is a contra-indication to attempts at reduction under the screen, and surgical reduction should be done immediately.

S. R. BEATTY, M.D.

GASTROSCOPY

The Present Status of Gastroscopy. Norman Giere. Minnesota Med., **21,** 550–553, August, 1938.

The instrument was introduced, in 1932, by Schindler. He has stated that it finds its greatest field of usefulness in gastritis. It has been found wanting in the diagnosis of this condition, however, by certain other observers.

Recently, two cases were reported from the Mayo Clinic in which carcinoma developed upon a hypertrophic gastritis, emphasizing the question again as to whether gastritis is not of importance in the causation of carcinoma.

Gastroscopy is probably less useful than x-ray examination in the diagnosis of ulcer of the stomach. The question is raised as to whether needless explorations may not be saved the patient by the gastroscopic diagnosis of inoperability. Gastroscopy gives important information in the differential diagnosis of benign and malignant ulcers of the stomach.

PERCY J. DELANO, M.D.

GOITER

Contribution to the Study of Basedow's Disease: Clinical Discussion. Deluen. Bull. et mém. soc. de radiol. méd. de France, **26,** 577–581, October, 1938.

There has been a sensible increase in the incidence of Basedow's disease in the west of France. While in certain cases the influence of the water supply seems indisputable, it is difficult, if not impossible, to discover the etiologic factor of this disease.

Two methods of treatment are worthy of being retained: surgical intervention and radiotherapy combined with electrotherapy and diathermy when possible. The percentage of cures can be sensibly increased if the patient can be maintained at complete rest during the period of treatment.

The author gives three doses of 250 r to both sides of the neck every other day. This series is repeated after three weeks and again after one month, if indicated by laboratory and clinical findings. Certain cases receive diathermy and ionization, with iodine over the thyroid in the intervals of radiotherapy. The author estimates his successful results at 65 per cent.

Treatment of ambulant cases is a mistake. The use of large doses of iodine may be dangerous. Treatment should be controlled by clinical and laboratory methods, including determinations of the basal metabolism and blood cholesterol.

S. R. BEATTY, M.D.

Contribution to the Study of Basedow's Disease: Basal Metabolism and Blood Cholesterol. Danet. Bull. et mém. soc. de radiol. méd. de France, **26,** 581, 582, October, 1938.

In the determination of the basal metabolism, the author prefers apparatus employing the open circuit rather than the closed circuit of the Benedict device.

The subject must be suitably prepared, without breakfast or recent medication, and at rest. The determination of the basal metabolism is a reliable diagnostic procedure. The author has frequently determined the blood sugar but has found no elevation in Basedow's disease. The blood cholesterol varies, in most cases inversely with the basal metabolism.

S. R. BEATTY, M.D.

GRENZ RAYS

Variations in the White Blood Picture of Patients with Lupus Following Grenz-ray Therapy. H. Lüsebrink. Strahlentherapie, **63,** 77, 1938.

The author followed the leukocyte count in 15 patients with lupus who received Grenz-ray therapy. In 14 cases he found a drop of leukocytes for several days after the exposure, followed by an increase, reaching its peak on approximately the seventeenth day, and a slow return to normal. The maximum figures were between 10,000 and 11,000. In 13 of the 15 studied cases, the lymphocytes increased after the treatment, reached a peak between the fourth and sixth day, returned to normal, and showed another increase between the fifteenth and twentieth day. The two peaks for the eosinophile count were between the sixth and the eighth day, and the fifteenth and the twentieth day. The author believes that the observed fluctuations in the white blood picture are due probably to the resorption of specific proteins released in the irradiated lupus lesions.

ERNST A. POHLE, M.D., Ph.D.

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